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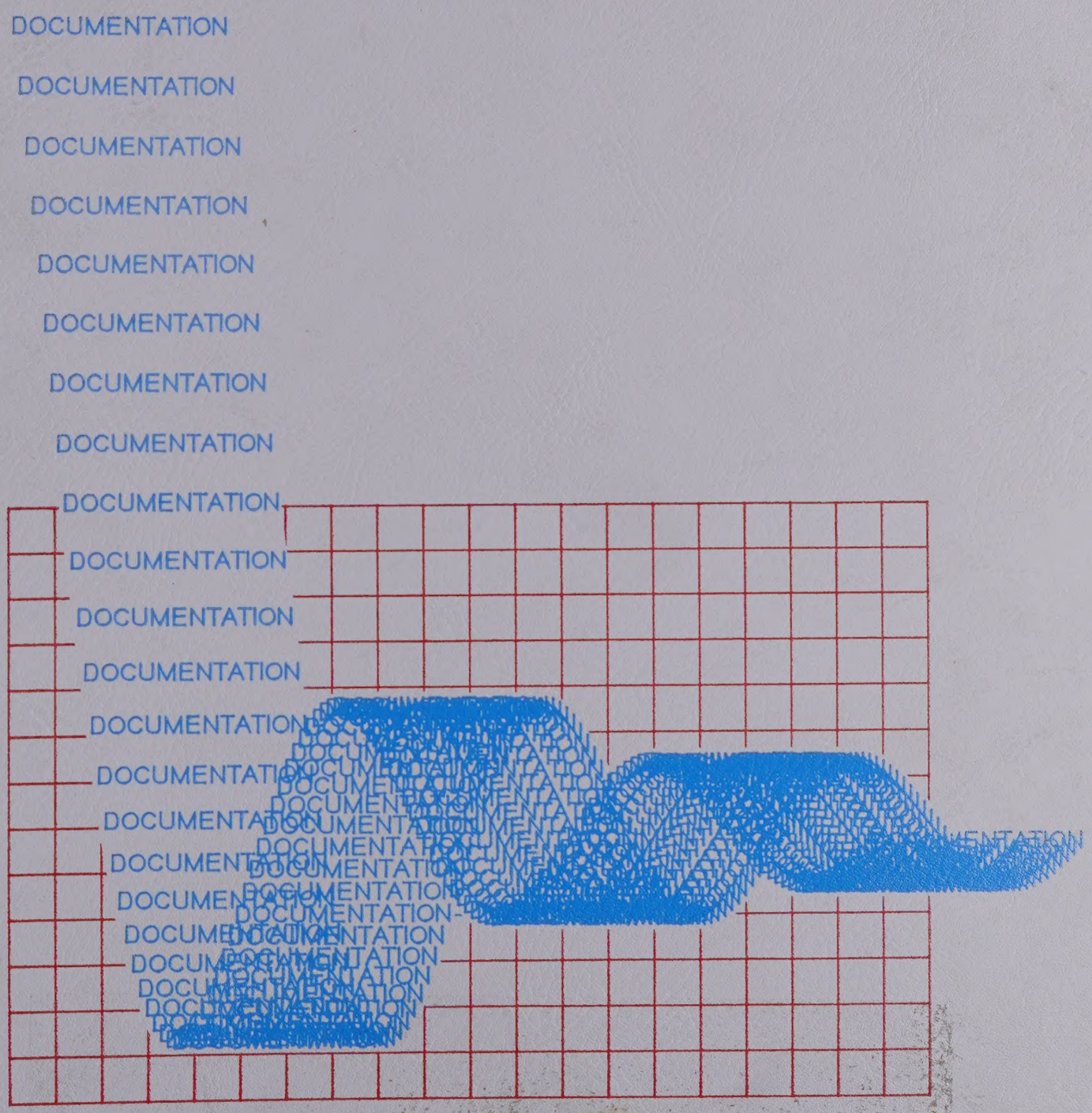

ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

SPECTRUM ANALYZER

FSP3
1093.4495.03

FSP7
1093.4495.07

Printed in the Federal
Republic of Germany

Tabbed Divider Overview

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Data Sheet

Safety Instructions
Certificate of Quality
EU Certificate of Conformity
List of R&S Representatives

Manuals for Spectrum Analyzer FSP

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Spectrum Analyzer FSP

The new standard in the medium class

Features

- 21 cm TFT colour display
- 1 Hz to 10 MHz RBW
- RMS detector for fast and precise measurements on digitally modulated signals with high repeatability
- Measurement routines for TOI, ACPR, OBW, amplitude statistics
- EMI bandwidths and quasi-peak detector

Speed

- 2.5 ms minimum sweep time in frequency domain
- 1µs sweep time in time domain
- Up to 30 GPIB measurements/s including trace transfer in frequency domain
- Up to 70 GPIB measurements/s including trace transfer in time domain
- Fast ACP measurement routine in time domain

Performance

- Total measurement error: 0.5 dB
- Displayed average noise level –155 dBm/Hz
- Phase noise: –113 dBc/Hz at 10 kHz
- Dynamic range of RMS detector: 100 dB

ROHDE&SCHWARZ

The new Spectrum Analyzers FSP from Rohde & Schwarz ...

- Unparalleled range of functions
- High measurement speed
- Maximum in precision

With the new FSP family, the well-known advantages of high-end analyzers FSE and FSIQ have been systematically integrated into the medium class of analyzers. FSP sets the standard for the medium class regarding the vital criteria of functionality, measurement speed and accuracy. The use of innovative techniques such as an highly integrated front end and fully digital signal processing at in the back end, together with R&S-developed ASICs, has resulted in a product of top-class specifications and high reliability.

... the new standard in the medium class

Performance

- Unique fast ACP mode for high-speed ACPR measurements in time domain using the standard-stipulated test filters

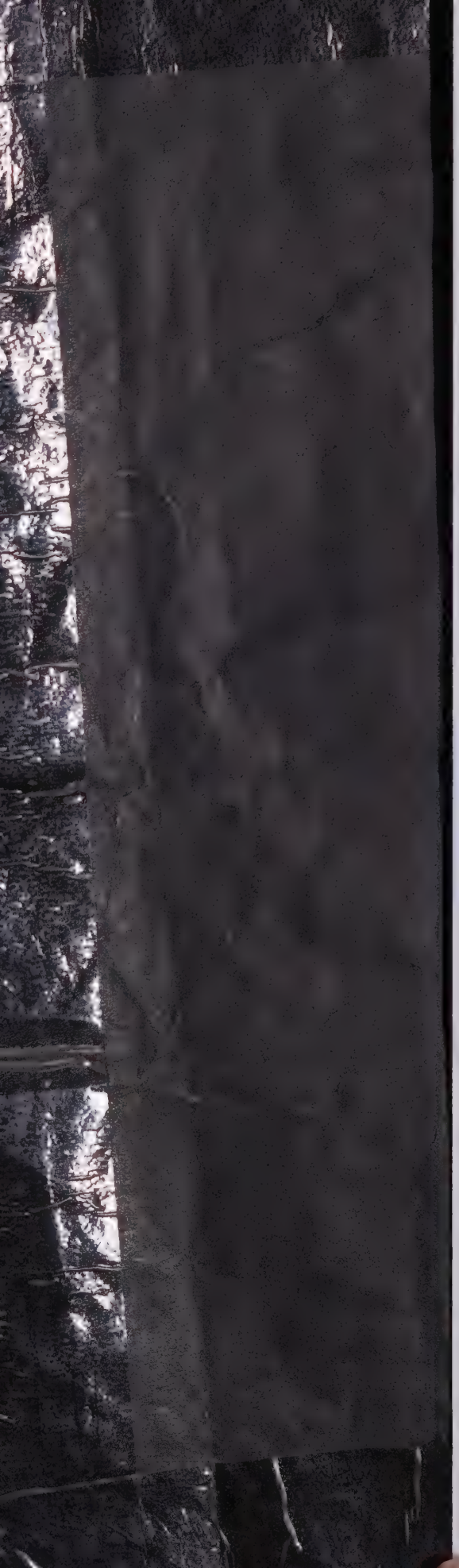
With 20 measurements/s in manual operation and digital filters with sweep time 2.5 times faster than comparable analog filters, FSP will also help in your day-to-day work to develop your product much faster.

Modern communication systems are aimed at attaining maximum spectral efficiency at high data rates. For the 3rd generation of CDMA mobile radio systems currently under development this is achieved, among other things, by high-precision power control.

FSP is the ideal partner in development and production, featuring the smallest level measurement uncertainty of all spectrum analyzers on the market, as well as excellent RF characteristics:

- 0.5 dB total measurement error allows higher tolerances for the DUT, thus increasing production yield.
- 0.2 dB linearity error is ideal for precise measurements, for example of gain control and ACPR.
- The RMS detector with 100 dB dynamic range measures power fast and accurately irrespective of the signal shape – almost like a thermal power sensor
- The displayed average noise level of typ. –155 dBm/Hz is attained without the use of preamplifiers and thus without any reduction in dynamic range.
- Typ. –145 dBc/Hz phase noise at 10 MHz offset offers optimum conditions for ACPR measurements on W-CDMA systems.
- Resolution bandwidths of up to 30 kHz are fully digital and provide – in addition to high selectivity – an ideal basis for accurate (adjacent-) channel measurements thanks to a maximum bandwidth error of 3%.

...with high-end characteristics



A wealth of functions ...

The FSP option list is short - all important functions and interfaces are implemented as standard.
FSP features future-oriented characteristics such as an RMS detector and a CCDF routine for fast statistical measurements on digitally modulated signals not offered by any other medium-class spectrum analyzer.

Function / Option	Standard	Option
Highly selective digital filters from 10 Hz to 30 kHz	●	
Fast FFT filters from 1 Hz to 30 kHz	●	
QP detector & EMI bandwidths 200 Hz, 9 kHz, 120 kHz	●	
2.5 ms sweep time in frequency domain	●	
1 µs sweep time in time domain	●	
Time-selective spectrum analysis with gating	●	
GPIB interface, IEEE 488.2	●	
RS232C serial interface, 9-pin D-Sub	●	
Centronics parallel interface, 25-pin D-Sub	●	
VGA output, 15-pin D-Sub	●	
PC-compatible screenshots on floppy disk or hard disk	●	
Storage of >500 results/settings	●	
Measurement speed manually up to 20 measurements/s	●	
Measurement speed GPIB up to 30 measurements/s	●	
SCPI-compatible GPIB command set	●	
FSE/FSIQ-compatible GPIB command set	●	
Fast ACP measurements in time domain	●	
CCDF and APD statistical measurement functions	●	
RMS detector with 100 dB dynamic range	●	
2-year calibration interval	●	
3-year warranty	●	
Cabinet for portable use	–	B1
AM/FM audio demodulator	–	B3
OCXO reference frequency	–	B4

... the new standard in the medium class

The new standard in the medium class ...

Features

The new FSP Spectrum Analyzers from Rohde & Schwarz are outstanding for their innovative measurements and a host of standard functions.
Instead of a long range of options, FSP offers as standard all the functions and interfaces you may expect from a spectrum analyzer of the 3rd millennium:

- Largest colour display in its class
- Resolution bandwidths from 1 Hz to 10 MHz
- Highly selective digital and FFT filters
- Quasi-peak detector and EMI bandwidths
- Convenient documentation of results as a hardcopy or file in PC compatible formats
- Interfaces: GPIB, Centronics, RS232
- Automatic test routines for measuring TOI, OBW and phase noise
- Split screen with separate settings and up to 3 traces per screen
- Editable limit lines including PASS/FAIL indication

On top of this, FSP features as standard the following unique attributes:

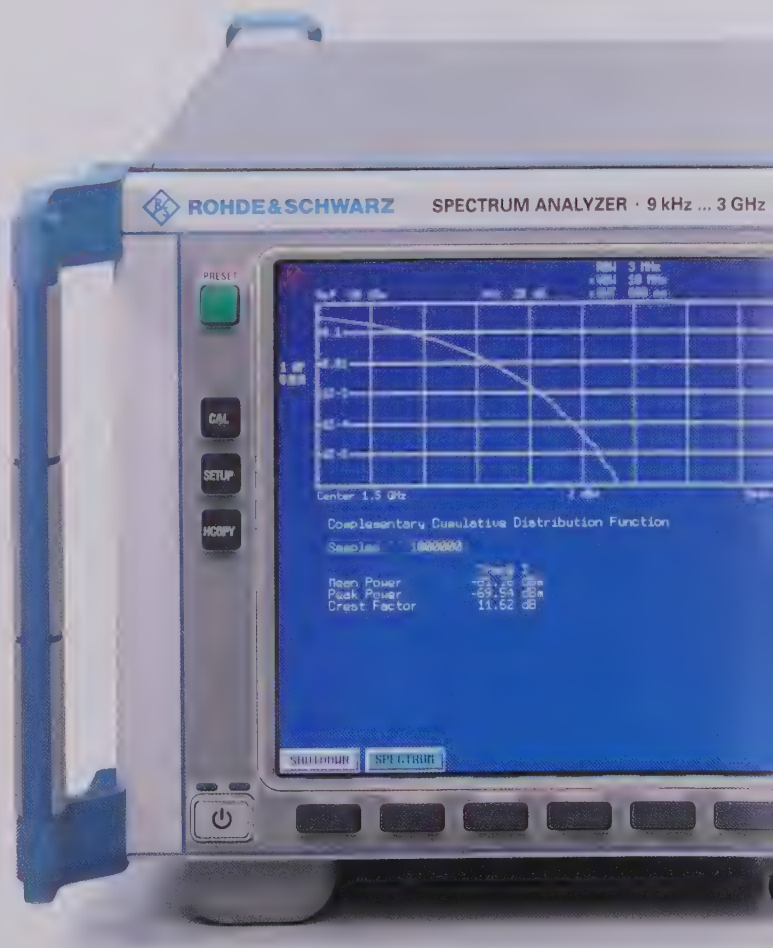
- RMS detector for fast and precise power measurements on digitally modulated signals in frequency and time domain
- Statistical measurement functions for determining crest factor and CCDF (complementary cumulative distribution function)

Featuring such a wealth of functions, FSP offers state-of-the-art spectrum analysis at an extremely attractive price-performance ratio.

Speed

Time is a finite resource – so high measurement speed is indispensable for competitiveness and cost-effective testing. Here, too, the new FSP offers characteristics that make it top of the class:

- Up to 30 measurements/s on GPIB interface including trace transfer of 501 binary data
- 70 measurements/s on GPIB interface in zero span mode including trace transfer of 501 binary data
- Minimum sweep time of 2.5 ms
- 1 µs time domain measurements



Performance

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. . . with high-end characteristics

High-end characteristics ...

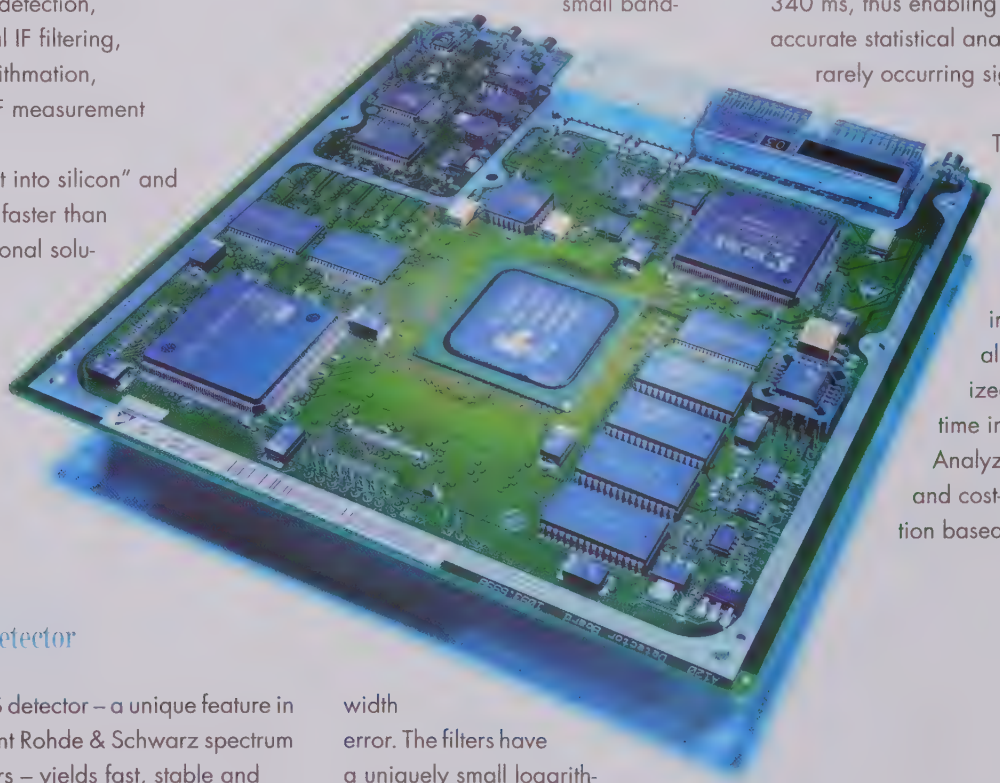
Rohde & Schwarz ASICs

Top-class performance as offered by FSP essentially depends on the extensive use of digital signal processing and LSI of highly integrated components.

For these demanding tasks, Rohde & Schwarz has developed ASICs tailored to the requirements of signal analysis. Key functions such as

- RMS detection,
- digital IF filtering,
- logarithmation,
- CCDF measurement

are "cast into silicon" and are thus faster than conventional solutions.



RMS detector

The RMS detector – a unique feature in all current Rohde & Schwarz spectrum analyzers – yields fast, stable and reproducible results also for complex signals such as CDMA. With an extremely high number of linear single measurements performed, followed by power integration, the detector avoids the measurement error inherent in conventional analyzers which results from the averaging of the log video signal.

The RMS detector of the FSP spectrum analyzers measures all modern communication signals with accuracy and speed unparalleled so far.

Logarithmic amplifier

FSP is equipped as standard with digital resolution filters of 10 Hz to 30 kHz of high selectivity and very small bandwidth error. The filters have a uniquely small logarithmic level error of <0.2 dB in the range 0 dB to –70 dB. They are implemented as ASIC functions, so their extremely high precision is attained without any reduction to measurement speed.

CCDF

The complementary cumulative distribution function, or briefly CCDF, describes the probability of a signal power exceeding a specific (usually the average) power. CCDF analysis is indispensable for determining the optimal transmitting power for CDMA signals assuming that clipping at known, short intervals is tolerable. FSP with its dedicated CCDF measurement routine furnishes 10^6 single results in only 340 ms, thus enabling extremely accurate statistical analysis even of rarely occurring signal peaks.

This analysis function, which is becoming more and more important, has also been realized for the first time in Spectrum Analyzer FSP as a fast and cost-effective solution based on ASICs.

The platform

Excellent technical data like those of FSP require a high-grade and service-friendly platform. All modules are accommodated optimally shielded and easy to exchange in a lightweight but stable frame. A low-noise bigsized blower in conjunction with low power consumption of 70 VA to 150 VA (depending on model) makes for high reliability.

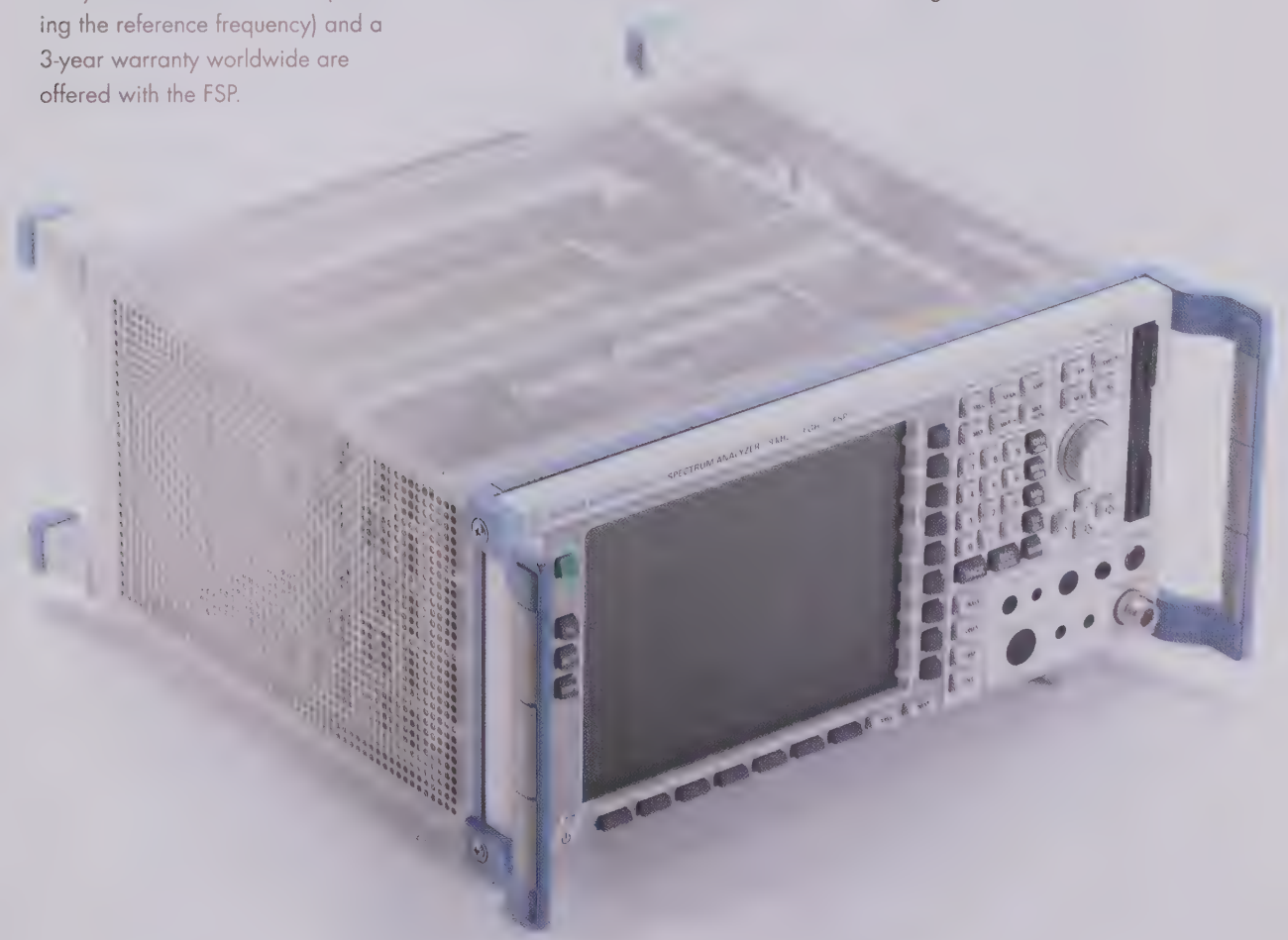
A 2-year calibration interval (excluding the reference frequency) and a 3-year warranty worldwide are offered with the FSP.

Fit for the future

Thanks to its modular design, FSP is optimally equipped to cope with all present and future tasks. The design takes into account both hardware and firmware extensions to safeguard your investment into the next millennium. So you can rely on your FSP to meet all requirements also in the years to come.

Ergonomics & design

FSP is the ergonomic standard in its class. The 21 cm (8.4") colour display is the largest and most brilliant in its category. Vertical and horizontal softkey bars allow the convenient handling even of complex measurement tasks. Parameters like frequency and amplitude are entered by means of dedicated hardkeys and unit keys. The rotary knob and the numerical keys have a fine response like those on high-end units.



...through innovative solutions

Innovative solutions.

Optimum dynamic range

Featuring the lowest average noise level in its class (DANL <–140 dBm at 10 Hz RBW), FSP determines even small signals accurately without the use of preamplifiers so that the full dynamic range is available. Together with the high intercept point this yields an intermodulation free range of 100 dB typ. – likewise a record in the medium class of analyzers.

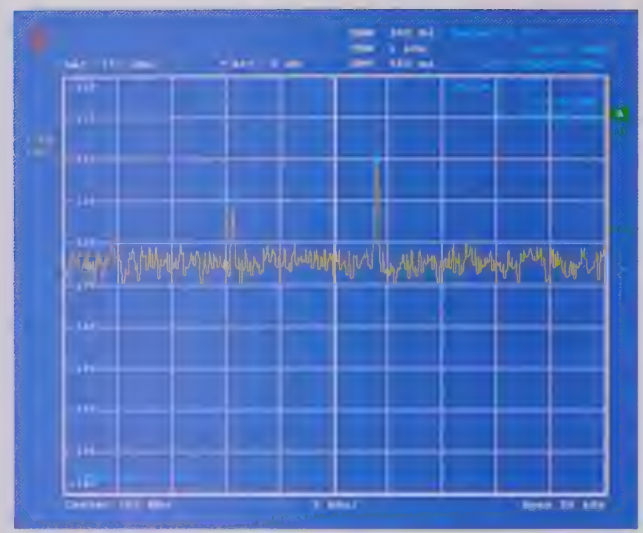
Lowest measurement uncertainty

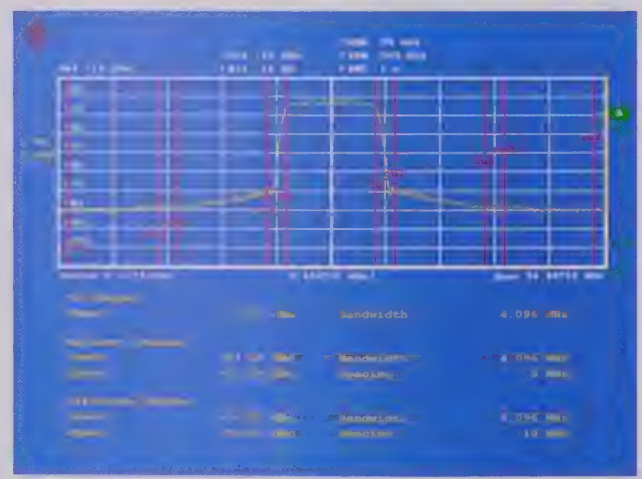
In the vital frequency range below 3 GHz, FSP is outstanding for ultra-low measurement uncertainty. The total measurement error is below 0.5 dB. This excellent value frequently does away with the need for a power meter in the lab and enables greater tolerances to be allowed for the DUT.

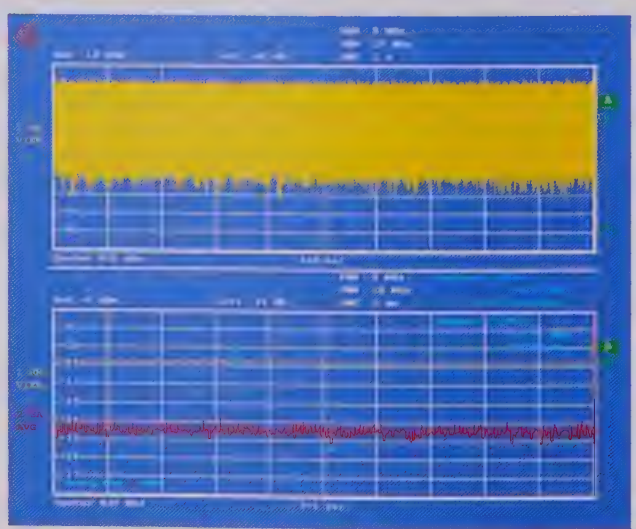
RMS detector

The unique RMS detector used in spectrum analyzers from Rohde & Schwarz measures modern, noise-like communication signals with maximum repeat accuracy and stability.

There are no correction factors nor the typical errors caused by averaging of logarithmic trace data, so the correct average power is displayed with high stability for all signal types – almost like with a thermal power meter.



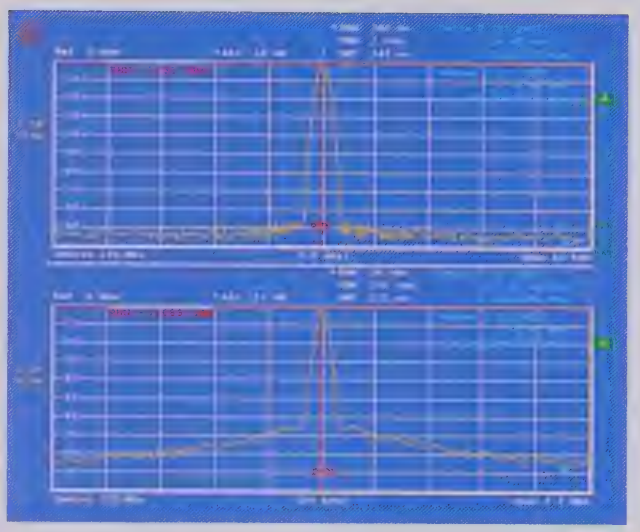




Phase noise

The low phase noise of FSP makes it suitable for demanding measurement tasks both in the vicinity of the carrier (typ. –113 dBc/Hz at 10 kHz) and far from the carrier (typ. –125 dBc/Hz at 1 MHz).

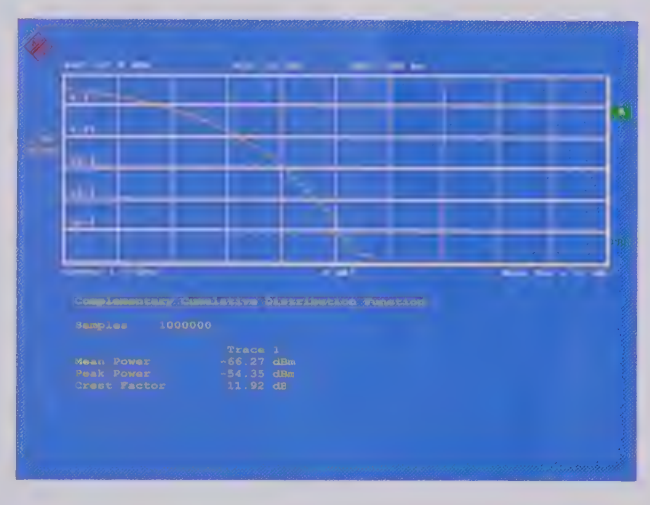
FSP is thus optimally equipped for performing spectral analysis and ACPR measurements on narrowband systems like IS136 or PDC as well as broadband systems like IS95 or W-CDMA.



CCDF measurements

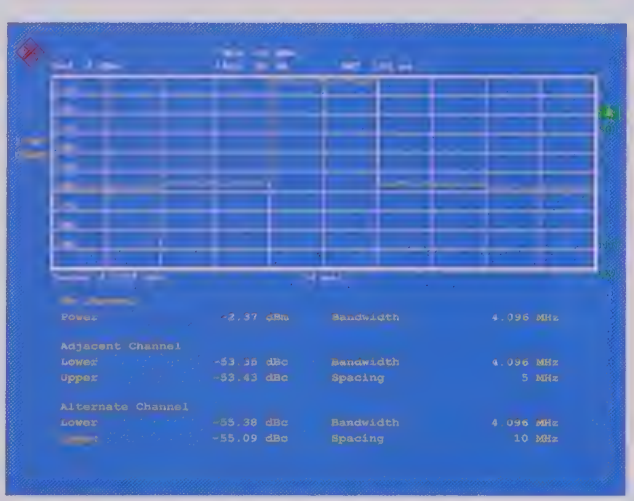
FSP is the first spectrum analyzer to offer statistical analysis of signals by means of the complementary cumulative distribution function (CCDF) as standard and at an impressively high speed.

FSP furnishes in only 340 ms the exact CCDF characteristic, average and peak power as well as the crest factor over 1 million measured values even for critical signals.



ACPR measurements

Adjacent channel power ratio (ACPR) measurements, which many mobile radio standards stipulate for components and units, are implemented in FSP by automatic test routines. All settings, measurements and filters required for a selected standard are activated at a keystroke. In addition to a multitude of preprogrammed standards, all settings for the channel width and channel spacing can be individually selected. Thanks to excellent dynamic range, lowest phase noise in its class and the RMS detector, FSP sets the standard in the medium class also for this kind of measurement.


Power -2.37 dBm Bandwidth 4.096 MHz
Adjacent Channel
Lower -53.38 dBc Bandwidth 4.096 MHz
Upper -53.43 dBc Spacing 5 MHz
Alternate Channel
Lower -55.38 dBc Bandwidth 4.096 MHz
-55.09 dBc Spacing 10 MHz

... for research & development

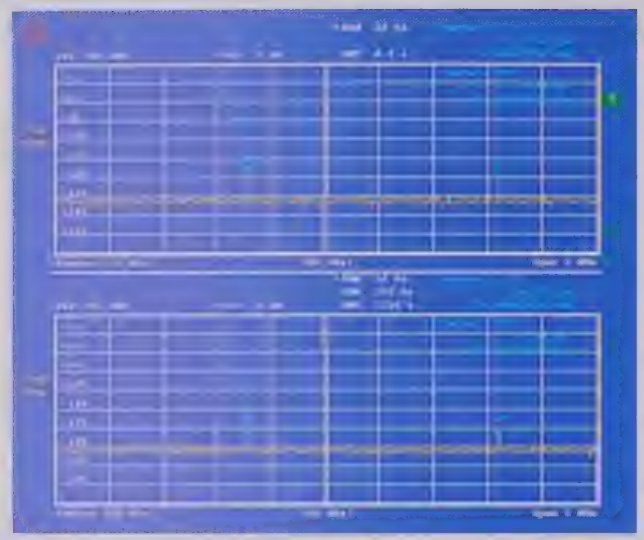
Innovative solutions...

High measurement speed

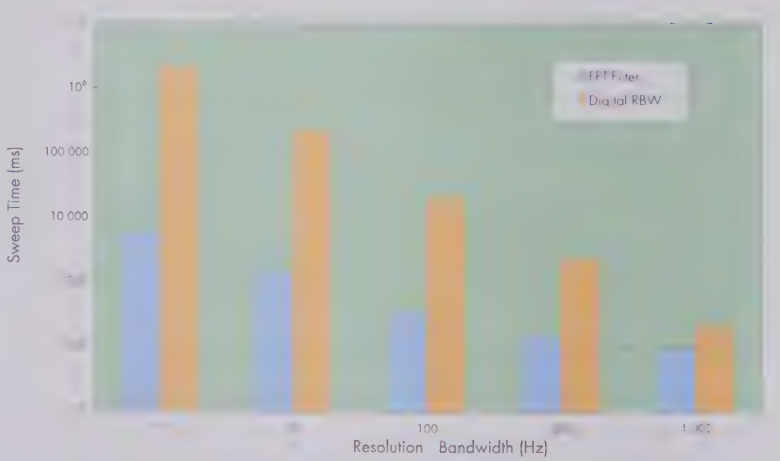
With 20 measurements/s in manual operation, minimum sweep time of 2.5 ms and 1 µs zero span sweep time as standard, FSP is ideal for time-critical applications.

The highly selective, fast-sweeping digital filters featuring "analog" behaviour allow measurements on pulsed signals as well as the use of the built-in frequency counter.

Where span/RBW ratios are high, measurement speed can be boosted by up to 300 times using the FFT filters also provided as standard.



Sweep Time for 200 kHz Span



30 measurements/s on GPIB interface

The standard high-speed GPIB interface enables up to 30 measurements/s including trace data transfer of 501 test points with the display switched off. In the zero span mode, 70 measurements/s are possible.

This characteristic makes FSP by far the fastest spectrum analyzer on the GPIB interface.

Thus valuable time can be saved in production and the throughput boosted enormously.

FSP supports you very effectively in getting your products more cost effective on the market.

	Sweeps/s Span 10 MHz, Sweep-Time 2.5 ms	**Sweeps/s** Span 0 Hz, Sweep-Time 100 µs
Format ASCII	25	60
Format Binary	30	70

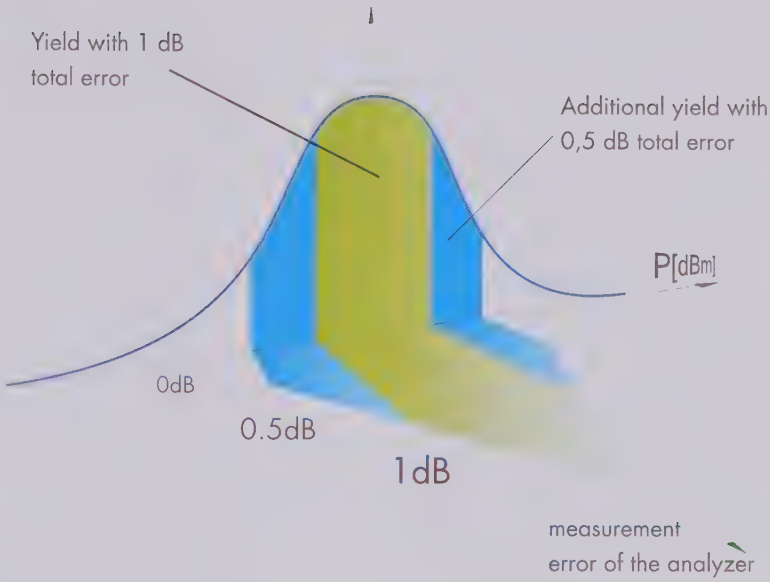
Display off, default coupling, single trace, 501 points

0.5 dB total error

Each measurement error can be split into the instrument error and the error introduced by the test setup. If the error of the spectrum analyzer is low, greater tolerances can be allowed for the test setup. This cuts down on costs and increases throughput.

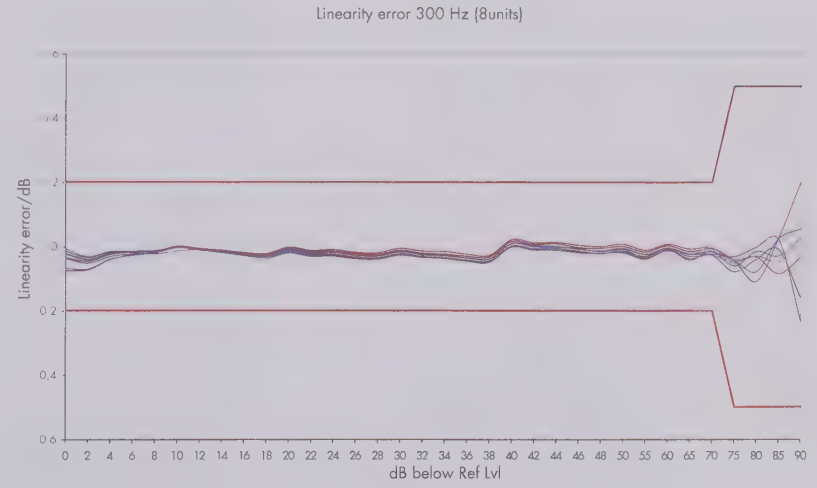
If the greater tolerances resulting from the small inherent error of the spectrum analyzer are allowed for the DUT, this helps to markedly reduce production rejects – an advantage that pays off immediately.

With a total error of 0.5 dB, FSP undisputedly ranks top way ahead of other medium-class analyzers.



0.2 dB linearity error

All modern mobile radio systems achieve high spectral efficiency through precise control of transmitter output power, among other measures. The correct functioning of gain control, which may be as much as 70 dB depending on the system, is checked against the nominal value in a large number of single measurements. Featuring linearity error of only 0.2 dB and fast power measurement routines especially for digitally modulated signals, FSP is the ideal choice where the focus is on reducing test time and rejects.



...for production

Innovative solutions...

Test routines TOI, OBW ...

FSP offers fast test routines for a multitude of typical measurement tasks, which make result postprocessing superfluous by supplying the desired data directly:

- Determination of TOI
- Occupied bandwidth (OBW)
- Burst power with peak, RMS, average and standard deviation
- Modulation depth of AM signals
- Phase noise
- Bandwidth marker

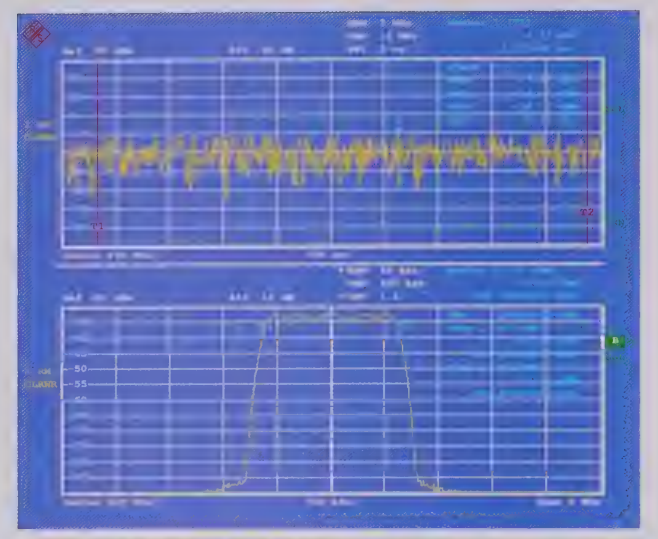
Of course these functions can also be used via the fast GPIB interface.

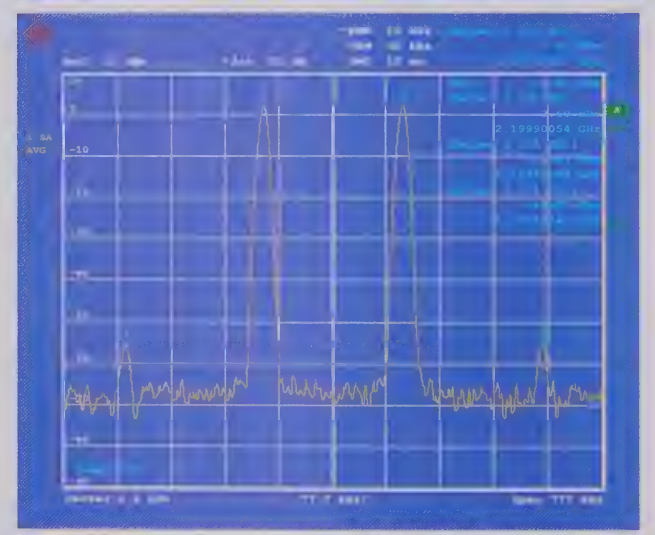
Environmental compatibility

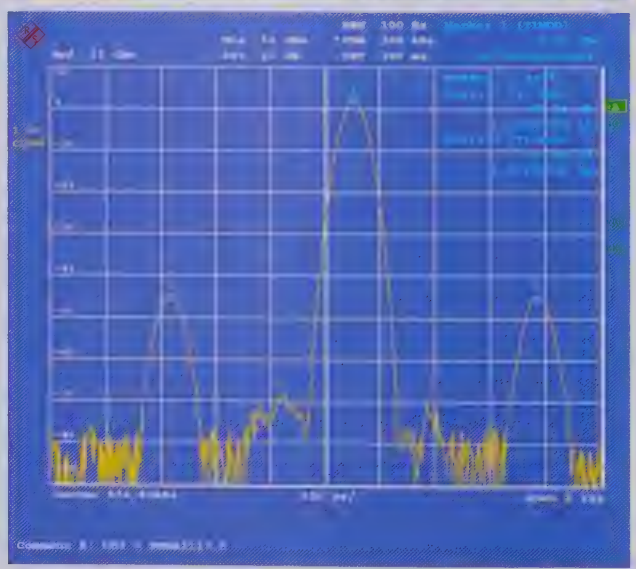
- Fast and easy disassembly
- Small number of materials
- Compatibility of material pairs
- Easy identification of substances through appropriate marking (plastics)

DESIGN AWARD WINNER 1998

INDUSTRIE FORUM DESIGN HANNOVER

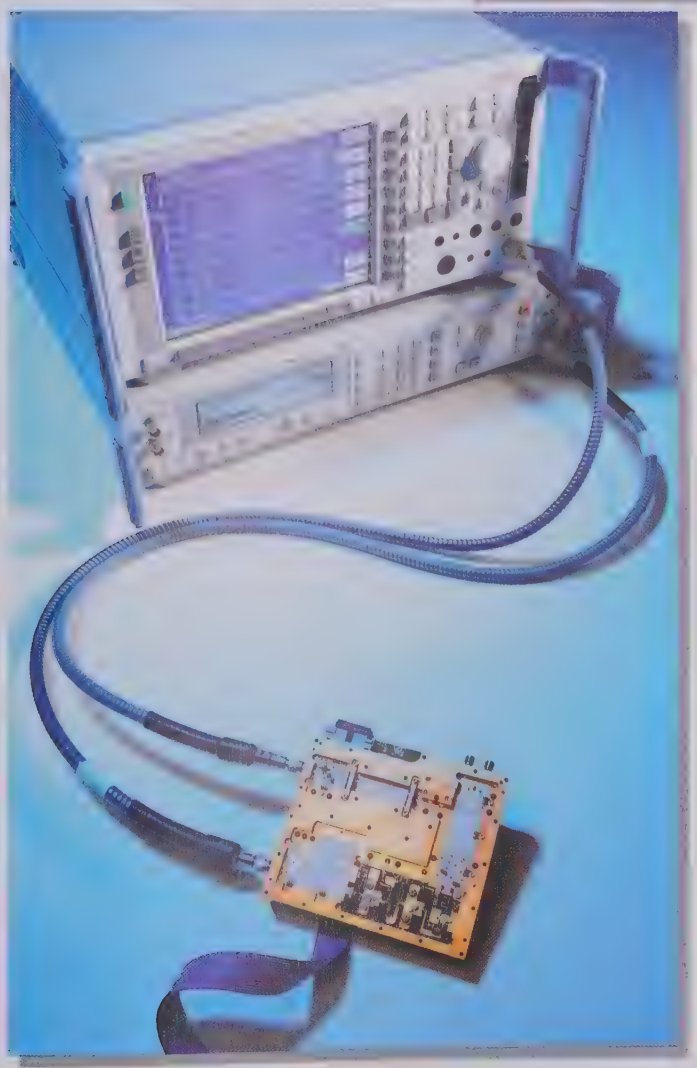






...for production

Complete measurement solutions, . . .



Open for the IT world

- PC-compatible screenshots, no conversion software needed
- Windows™ printer support
- LabWindows driver
- LabView driver
- Software
- SCPI-compatible
- FSE-compatible GPIB command set
- GPIB command set with search function on CD-ROM
- After-sales service
- 3-year warranty
- 2-year calibration cycle
- Customized training
- Pre-sales support
- Solution-oriented consulting
- Leasing

and more

. . . no guessing games

Specifications

Specifications are guaranteed under the following conditions:
30 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed.
Data without tolerances: typical values only.
Data designated "nominal" apply to design parameters and are not tested.
Data designated "σ = xx dB" is shown as standard deviation.

	FSP-3	FSP-7
Frequency		
Frequency range	9 kHz to 3 GHz	9 kHz to 7 GHz
Frequency resolution	0.01 Hz	
Reference frequency, internal nominal		
Aging per year [1]	1×10^{-6}	
Temperature drift (+5 °C to 45 °C)	1×10^{-6}	
with option FSP-B4 (OCXO)		
Aging per year [1]	1×10^{-7}	
Temperature drift (+5 °C to 45 °C)	1×10^{-8}	
External reference frequency	10 MHz	
Frequency display	with marker or frequency counter	
Marker resolution	span/500	
Error (sweep time >3·x auto sweep time)	± (marker frequency x reference error + 0.5% x span + 10% x resolution bandwidth + ½ (last digit))	
Frequency counter resolution	0.1 Hz to 10 kHz (selectable)	
Count accuracy (S/N >25 dB)	±(frequency x reference error + ½ (last digit))	
Frequency span	0 Hz, 10 Hz to 3 GHz	0 Hz, 10 Hz to 7 GHz
span error	0.1%	
Spectral purity (dBc/Hz) SSB phase noise, f = 500 MHz, for f > 500 MHz see diagram below		
carrier offset		
100 Hz	<–90, typ –94	
1 kHz	<–100, typ. –108	
10 kHz	<–106, typ. –113	
100 kHz [2]	<–110, typ. –113	
1 MHz [2]	<–120, typ. –125	
10 MHz	typ. –145	
Residual FM		
f = 500 MHz, RBW 1 kHz, SWT 100ms	typ. 3 Hz	
Sweep time		
Span ≥10 Hz	2.5 ms to 16000 s in 10% steps	
Error	1 %	
Span 0 Hz	1 us to 16000 s in 5% steps	
resolution	125 ns	

1) After 30 days of operation.
2) Valid for span >100 kHz.

Typical values for SSB phase noise:

offset	f_{in} = 500 MHz	f_{in} = 3 GHz	f_{in} = 7 GHz
100 Hz	–94 dBc/Hz	–90 dBc/Hz	–84 dBc/Hz
1 kHz	–105 dBc/Hz	–100 dBc/Hz	–94 dBc/Hz
10 kHz	–113 dBc/Hz	–108 dBc/Hz	–104 dBc/Hz
100 kHz	–113 dBc/Hz	–108 dBc/Hz	–106 dBc/Hz
1 MHz	–125 dBc/Hz	–118 dBc/Hz	–118 dBc/Hz

	FSP 3	FSP 7
Resolution bandwidths		
Bandwidths	10 Hz to 10 MHz (-3 dB) in 1-, 3- steps	
EMI-Bandwidths	200 Hz, 9 kHz, 120 kHz (-6 dB)	
Bandwidth error		
≤30 kHz	< 3 %	
100 kHz to 3 MHz	< 10 %	
10 MHz	+10 %, –30 %	
Shape factor 60:3 dB		
≤30 kHz	<5 (gaussian filters)	
100 kHz to 3 MHz	<15 (4-pole synchronous tuned filters)	
10 MHz	< 7	
Shape factor 60:6 dB EMI bandwiths	< 6	
Video bandwidths	1 Hz to 10 MHz in 1-, 3-steps	
FFT filter		
Bandwidths	1 Hz to 30 kHz (- 3 dB) in 1-, 3-steps	
Bandwidth error	5 %, nominal	
Shape factor 60:3 dB	2.5 nominal	
Level		
Display range	displayed noise floor to 30 dBm	
Maximum input level		
RF attenuation 0 dB		
DC voltage	50 V	
CW RF power	20 dBm (=0.3 W)	
Pulse spectral density	97 dBµV/MHz	
RF attenuation ≥10 dB		
CW RF power	30 dBm (=1 W)	
Max. pulse voltage	150 V	
Max. pulse energy (10 µs)	1mWs	
1-dB compression of input mixer		
0-dB RF attenuation, f>200 MHz	0 dBm nominal	
Intermodulation		
3rd-order intermodulation		
Intermodulation free dynamic range, level 2 x -30 dBm, Δf > 5 · RBW or 10 kHz, whichever is the greater value		
Frequency		
20 MHz to 200 MHz	>70 dBc, T.O.I. >5 dBm	
200 MHz to 3 GHz	>74 dBc, T.O.I. >7 dBm	
3 GHz to 7 GHz	–	>80 dBc, T.O.I. >10 dBm
Second harmonic Intercept point (S.H.I)		
Frequency <50 MHz	25 dBm	
50 MHz to 3 GHz	35 dBm	
3 GHz to 7 GHz	–	45 dBm
Displayed average noise floor (0-dB RF attenuation, RBW 10 Hz, VBW 1 Hz, 20 averages, trace average, span 0 Hz, termination 50 Ohm		
Frequency:		
9 kHz	<–95 dBm	
100 kHz	<–100 dBm	
1 MHz	<–120, typ. –125 dBm	
10 MHz to 3 GHz	<–140, typ. –145 dBm	–
10 MHz to 7 GHz	–	<–138, typ. –143 dBm
Immunity to interference		
Image frequency	>70 dB	
Intermediate frequency	>70 dB	
Spurious response (f >1 MHz, without input signal, 0-dB attenuation)	<–103 dBm	
Spurious response (with input signal, (mixer level <–10 dBm, Δf > 100 kHz)	<–70 dBc	

	FSP 3	FSP 7
Level display		
Screen	501 x 400 pixel (one diagram), max. 2 diagrams with independent settings	
Log level axis	10 to 200 dB, in steps of 10 dB	
Linear level axis	10% of reference level per level division, 10 divisions	
Trace	max. 3, with two diagrams on screen max 3 per diagram	
Trace Detector	Max. Peak, Min. Peak, Auto Peak, Sample, Quasi-Peak, Average, RMS	
Trace Functions	Clear/Write, Max. Hold, Min. Hold, Average	
Setting range of reference level		
Logarithmic level display	–130 dBm to 30 dBm, in steps of 0.1 dB	
Linear level display	70.71 nV to 7.07 V in steps of 1%	
Units of level axis	dBm, dBmV, dBµV, dBµA, dBpW (log level display), mV, µV, mA, µA, pW, nW (linear level display)	
Level measurement error		
Absolute error at 128 Mhz, –30dBm (RF attenuation 10 dB, RBW 10 kHz Ref. level –20 dBm)	< 0.2 dB (σ = 0.07 dB)	
Frequency response		
≤50 kHz	<+0.5/– 1.0 dB	
50 kHz to 3 GHz	< 0.5 dB (σ = 0.17 dB)	
3 GHz to 7 GHz	<2 dB (σ = 0.7 dB)	
Attenuator error	<0.2 dB (σ = 0.07 dB)	
Error of reference level	<0.2 dB (σ = 0.07 dB)	
Display nonlinearity LOG/LIN (S/N >16 dB)		
RBW ≤30 kHz		
0 dB to –70 dB	<0.2 dB (σ = 0.07 dB)	
–70 dB to –90 dB	<0.5 dB (σ = 0.17 dB)	
RBW ≥ 100 kHz		
0 dB to –50 dB	<0.2 dB (σ = 0.07 dB)	
–50 dB to –70 dB	<0.5 dB (σ = 0.17 dB)	
Bandwidth switching error (ref.: RBW = 3 kHz)		
10 Hz to 30 kHz, FFT	<0.1 dB (σ = 0.03 dB)	
100 kHz to 10 MHz	<0.2 dB (σ = 0.07 dB)	

Trigger functions

Trigger	
Span ≥10 Hz	
Trigger source	free run, video, external, IF-level (mixer level >–20 dBm)
Trigger offset	125 ns to 100 s, resolution 125 ns min. (or 1% of offset)
Span = 0 Hz	
Trigger source	free run, video, external, IF-level (mixer level >–20 dBm)
Trigger offset	± 125 ns to 100 s, resolution 125 ns min., dependent on sweep time
Error of delay time offset	± (125 ns + (0.1% x delay time))
Gated sweep	
Trigger source	external, IF-level, Video
Gate delay	1 µs to 100 s
Gate length	125 ns to 100 s, resolution min. 125 ns or 1% of gate length
Error of gate length	± (125 ns + (0.05% x gate length))

	FSP 3	FSP 7
Inputs & outputs (front panel)		
RF input	N female, 50 Ohm	
VSWR (RF attenuation >0 dB)		
f <3 GHz	1.5	1.5
f <7 GHz	–	2.0
Input attenuator	0 dB to 70 dB in 10 dB steps	
Probe power supply	+15 V DC, –12.6 V DC and ground, max. 150 mA	
Keyboard Connector	PS/2 female for MF-2 keyboard	
AF output (optional)	3.5 mm mini jack	
Output impedance	10 Ohm	
Open-circuit voltage	Adjustable, up to 1.5 V	
Inputs & outputs (rear panel)		
IF 20.4 MHz	Z_{out} = 50 Ohm, BNC female	
Bandwidth		
RBW ≤30 kHz	2.6x resolution bandwidth, min. 2.6 kHz	
RBW ≥100 kHz	equal to resolution bandwidth	
Level		
RBW ≤30 kHz, FFT	–10 dBm at reference level, mixer level > –60 dBm	
RBW ≥100 kHz	0 dBm at reference level, mixer level >– 60 dBm	
Reference frequency		
Output	BNC female	
Output frequency	10 MHz	
Level	0 dBm nominal	
Input	10 MHz	
Required level	0 dBm from 50 Ohm	
Power supply for noise source	BNC female, 0 and 28 V, switchable	
External trigger/gate input	BNC female, >10 kOhm	
Voltage	TTL level	
IEC/IEEE-bus control	interface to IEC-625-2 (IEEE 488.2)	
Instruction set	SCPI 1997.0	
Connector	24 pin Amphenol female	
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0	
Serial interface	RS-232-C (COM), 9 pin D-SUB connector	
Printer interface	parallel (centronics compatible)	
Mouse connector	PS/2 female	
Connector f. external monitor (VGA)	15 pin D-SUB connector	

General data

Display	21 cm TFT color display (8.4")
Resolution	640 x 480 pixels (VGA resolution)
Pixel failure rate	$<2 \times 10^{-5}$
Mass memory	1.44 Mbyte 3 ½" diskette (built-in disk drive), harddisk
Data storage	>500 instrument settings and traces
Temperature range	
Nominal temperature range	+ 5 °C to +40 °C
Limit temperature range	+ 5 °C to +45 °C
Storage temperature range	–40 °C to +70 °C
Climatic loading	+40 °C at 95% relative humidity (IEC 68–2–3)

	FSP 3	FSP 7
Mechanical stress		
Sinusoidal vibration	5 Hz to 150 Hz, max. 2 g at 55 Hz; 0.5 g from 55 Hz to 150 Hz; to IEC 68-2-6, IEC 68-2-3, IEC 1010-1, MIL-T-28800D, class 5	
Random vibration	10 Hz to 100 Hz, acceleration 1 g rms	
Shock	40 g shock spectrum, to MIL-STD-810C and MIL-T-28800D, classes 3 and 5	
Recommended calibration interval	2 years for operation with external reference, internal reference 1 year	
Power supply		
AC supply	100 VAC to 240 VAC, 50 Hz to 400 Hz, 3.1 to 1.3 A, class of protection I to VDE 411	
typical power consumption	70 VA	120 VA
Safety	to EN 61010-1, UL 3111-1, CSA C22.2 No. 1010-1, IEC 1010-1	
Test mark	VDE, GS, CSA, CSA-NRTL/C	
Dimensions in mm (W x H x D)	412 x 197 x 417	
Weight	13.5 kg	15 kg

Ordering information

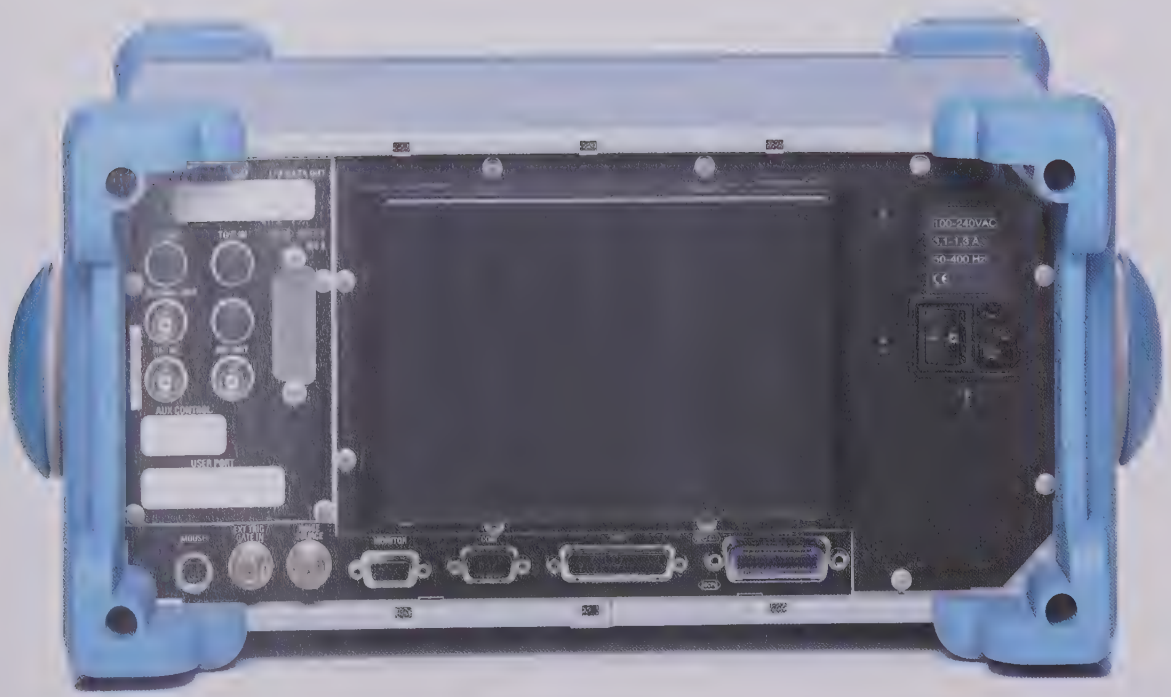
Order designation	Type	Order No
Spectrum Analyzer 9 kHz to 3 GHz	FSP 3	1093.4495.03
Spectrum Analyzer 9 kHz to 7 GHz	FSP 7	1093.4495.07
Accessories supplied		
Power cable, operating manual, service manual		

Options

Order designation	Type	Order No
Delete manuals	FSP-B0	1129.8394.02
Rugged case, Carrying handle (factory-fitted)	FSP-B1	1129.7998.02
AM/FM demodulator	FSP-B3	1129.6491.02
High stability reference (OCXO)	FSP-B4	1129.6740.02
Software		
Noise Measurement Software	FS-K3	1057.3028.02

Recommended extras

Order designation	Type	Order No.
Headphones	–	0708.9010.00
US Keyboard with trackball	PSP-Z2	1091.4100.02
PS/2 Mouse	FSE-Z2	1084.7043.02
Color Monitor, 15", 230 V	PMC3	1082.6004.02
IEC/IEEE-Bus Cable, 1 m	PCK	0292.2013.10
IEC/IEEE-Bus Cable, 2 m	PCK	0292.2013.20
19" Rack Adapter	ZZA 478	1096.3248.00
Trolley	ZZK-1	1014.0510.00
Matching Pads, 75 Ohm		
L section	RAM	0358.5414.02
Series resistor, 25 Ohm	RAZ	0358.5714.02
SWR Bridge, 5 to 3000 MHz	ZRB2	0373.9017.52
SWR Bridge, 40 kHz to 4 GHz	ZRC	1039.9492.52
High-Power Attenuators, 100 W		
3/6/10/20/30 dB	RBU 100	1073.8820.XX (XX=03/06/10/20/ 30)
High-Power Attenuators, 50 W		
3/6/10/20/30 dB	RBU 50	1073.8895.XX (XX=03/06/10/20/ 30)



Fax Reply (FSP Spectrum Analyzer)

- ❑ **Please send me an offer**
- ❑ **I would like a demo**
- ❑ **Please call me**
- ❑ **I would like to receive your free-of-charge CD-ROM catalogs**

Others: _____

_____

_____

Name: _____

Company/Department: _____

Position: _____

Address: _____

_____

_____

Country: _____

Telephone: _____

Fax: _____

E-mail: _____

Certified Quality System
ISO 9001
DQS REG. NO 1954-04

ROHDE&SCHWARZ

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Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

Observe operating instructions

Warning of a danger spot (e.g. when lifting unit)

PE terminal

Ground terminal

Danger! Shock hazard

Warning! Hot surfaces

Ground

Attention! Electrostatic sensitive devices require special care

1. This unit may be used only in the operating conditions and positions specified by the manufacturer, unless otherwise agreed, the following applies to all products:

   Overvoltage category II, protection 2X, Pollution severity 2, Climatic category 2, altitude max. 2000 m.

   This unit may be operated only from supply networks fused with max. 16 A

2. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures should be taken to avoid any hazards (e.g. appropriate measuring equipment, fuse, current limiting, electrical separation, insulation)

3. Before connecting the unit to be permanently wired, the PE conductor at the unit must first be connected to the PE conductor on site before any other connection is made. Installation and cabling of the unit may be performed only by qualified technical personnel.

4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.

5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.

6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.

7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.

8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.

9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. Any additional safety instructions given in this manual are also to be observed.

Certified Quality System

ISO 9001

DQS REG. NO 1954-04

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist nach ISO 9001 zertifiziert.

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde & Schwarz quality management system is certified according to ISO 9001.

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde & Schwarz a été homologué conformément à la norme ISO 9001.

ROHDE & SCHWARZ

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 99049

This is to certify that:

Equipment type	Stock No.	Designation
FSP3	1093.4495.03	Spectrumanalyzer 9 kHz to 3 GHz
FSP7	1093.4495.07	Spectrumanalyzer 9 kHz to 7 GHz

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995
EN50081-1 : 1992
EN50082-2 : 1995

Affixing the EC conformity mark as from 1999

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Mühldorfstr. 15, D-81671 München

Munich, 1999-09-13

Central Quality Management FS-QZ / Becker

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Contents of Manuals for Spectrum Analyzer FSP

Operating Manual FSP

The operating manual describes the foll,owing models and options of spectrum analyzer FSP:

- FSP3 9 kHz to 3 GHz
- FSP7 9 kHz to 7 GHz

- Option FSP-B4 OCXO - reference oscillator
- Option FSP B3 audio demodulator

The present operating manual contains comprehensive information about the technical data of the instrument, the setup and putting into operation of the instrument, the operating concept and controls as well as the operation of the FSP via the menus and via remote control. Typical measurement tasks for the FSP are explained using the functions offered by the menus and a selection of program examples.

In addition the operating manual gives information about maintenance of the instrument and about error detection listing the error messages which may be output by the instrument. It is subdivided into 9 chapters:

Chapter 1 describes the control elements and connectors on the front and rear panel as well as all procedures required for putting the FSP into operation and integration into a test system.

Chapter 2 gives an introduction to typical measurement tasks of the FSP which are explained step by step.

Chapter 3 describes the operating principles, the structure of the graphical interface and offers a menu overview.

Chapter 4 forms a reference for manual control of the FSP and contains a detailed description of all instrument functions and their application. The chapter also lists the remote control command corresponding to each instrument function.

Chapter 5 describes the basics for programming the FSP, command processing and the status reporting system.

Chapter 6 lists all the remote-control commands defined for the instrument. At the end of the chapter a alphabetical list of commands and a table of softkeys with command assignment is given.

Chapter 7 contains program examples for a number of typical applications of the FSP.

Chapter 8 describes preventive maintenance and the characteristics of the instrument's interfaces.

Chapter 8 gives a list of error messages that the FSP may generate.

Chapter 9 contains a list of error messages.

Chapter 10 contains an index for the operating manual.

Service Manual - Instrument

The service manual - instrument informs on how to check compliance with rated specifications, on instrument function, repair, troubleshooting and fault elimination. It contains all information required for the maintenance of FSP by exchanging modules.

Contents - Chapter 1 " Preparing for Operation "

1 Preparing for Operation

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Rear View 1.9
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Putting into Operation 1.12
Setting up the Instrument 1.12
Stand-alone Operation 1.12
Rackmounting 1.13
EMI Protection Measures 1.13
Connecting the Instrument to the AC Supply 1.13
Switching on/off the Instrument 1.14
Switching on the Instrument 1.14
Startup Menu and Booting 1.15
Switching off the FSP 1.15
Power-Save Mode 1.15
Battery-Powered Memory 1.16
Functional Test 1.16
Windows NT 1.17
Connecting an External Keyboard 1.18
Connecting a Mouse 1.19
Connecting an External Monitor 1.20
Connecting an Output Device 1.21
Installing Windows NT Software 1.27

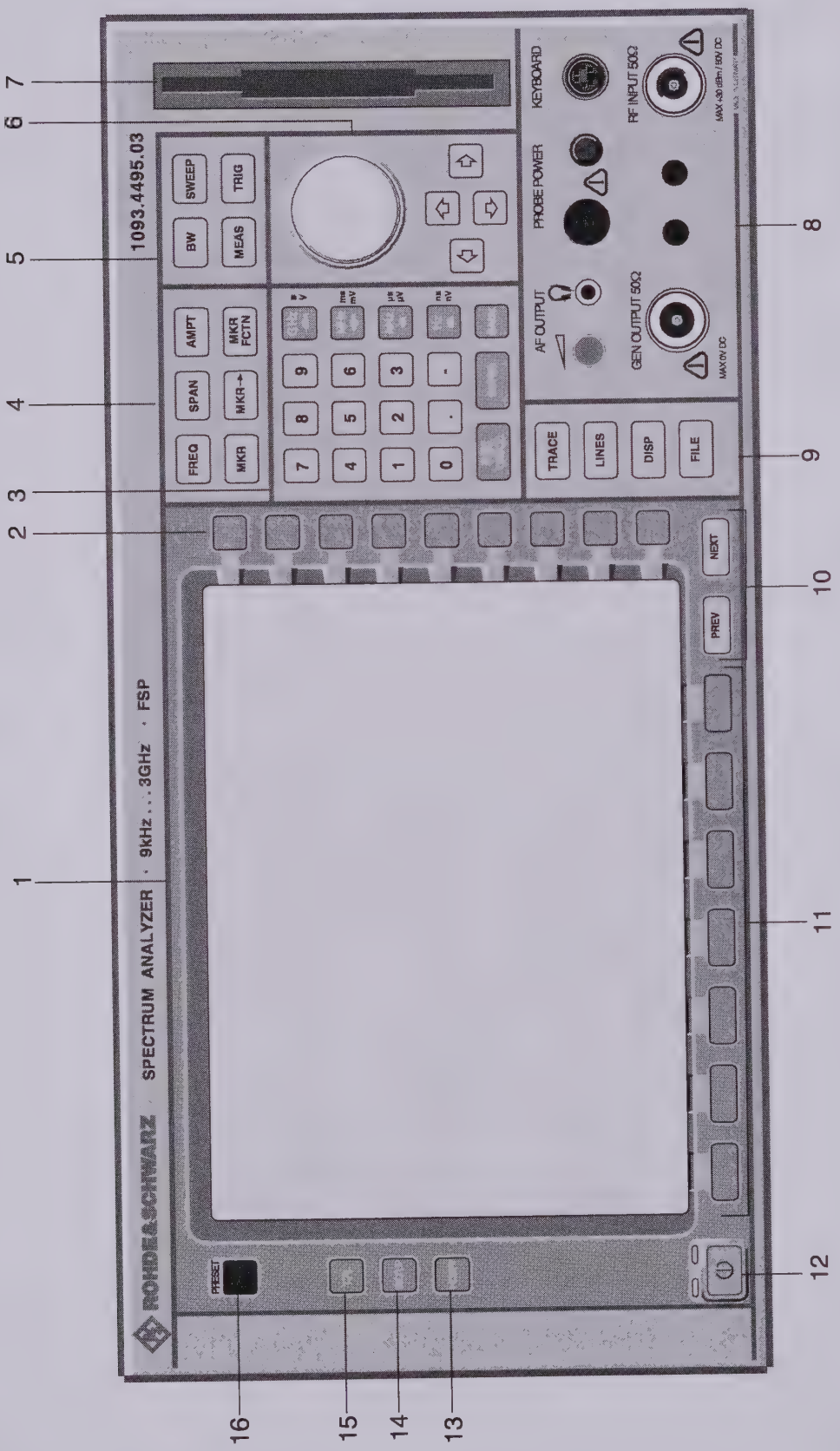


Fig. 1-1 Front View

1 Preparing for Operation

Chapter 1 describes the controls and connectors of the Spectrum Analyzer FSP by means of the front and rear view. Then follows all the information that is necessary to put the instrument into operation and connect it to the AC supply and to external devices.

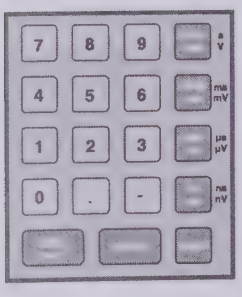
A more detailed description of the hardware connectors and interfaces can be found in chapter 8. Chapter 2 provides an introduction into the operation of the FSP by means of typical examples of configuration and measurement; for the description of the concept for manual operation and an overview of menus refer to chapter 3.

For a systematic explanation of all menus, functions and parameters and background information refer to the reference part in chapter 4.

For remote control of the FSP refer to the general description of the SCPI commands, the instrument model, the status reporting system, and command description in chapter 5 and 6.

Description of Front and Rear Panel Views

Front View

1		
	Display Screen	see Chapter 3
2		
	Softkeys	see Chapter 3
3		
	Keypad for data input 0...9 input numbers . input decimal point – change sign ESC CANCEL – close input field (for uncompleted or already closed inputs, the original entry is kept) – erase the current entry in input field (beginning of an input) – close message window (status, error and warning messages) ENTER close the data input. BACK – erase last character input for uncompleted input – restore previous input (undo)	see Chapter 3

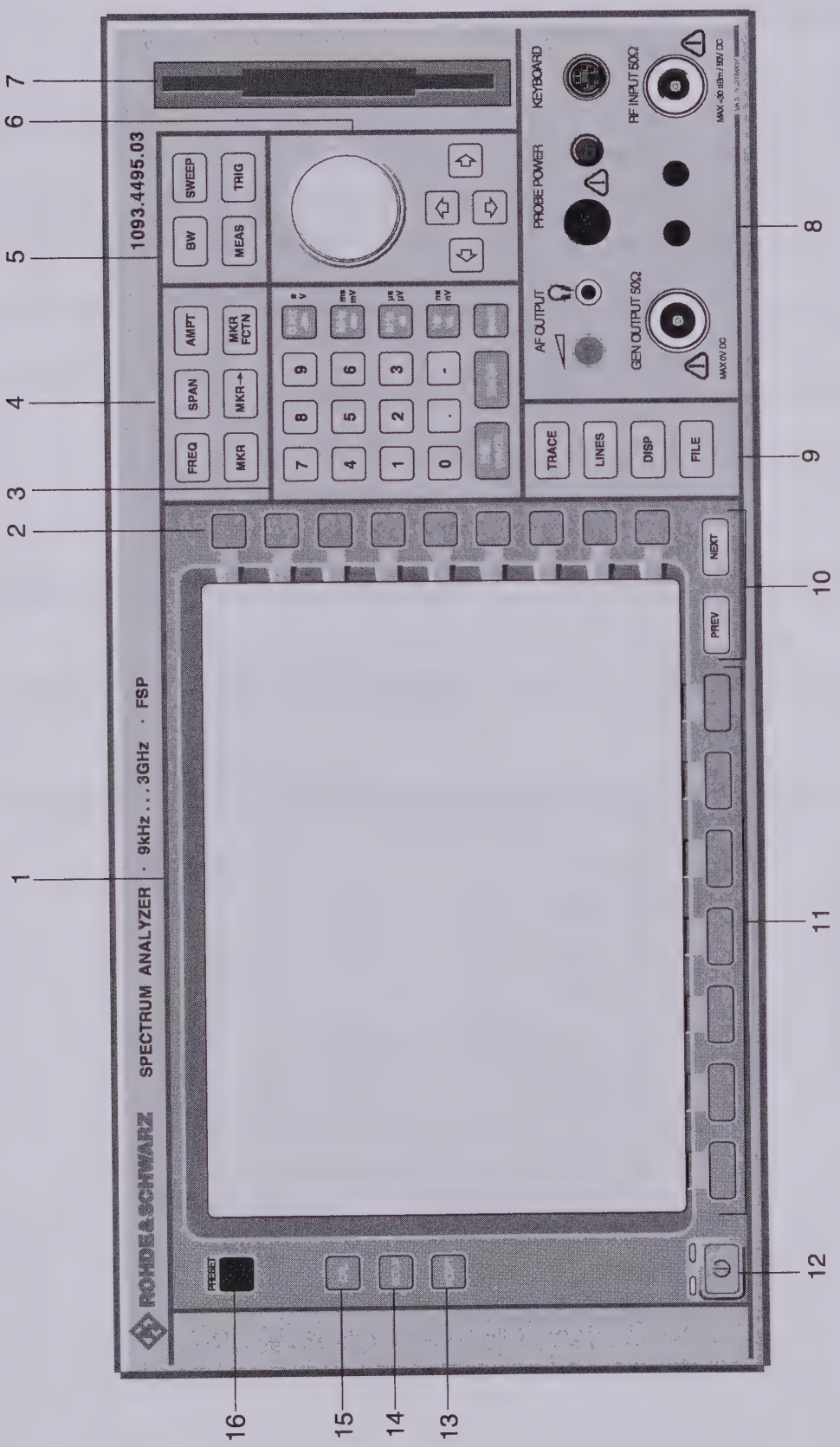
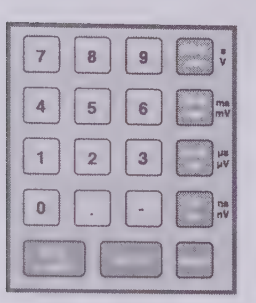


Fig. 1-1 Front View



Keypad for data input

GHz s
-dBm V
MHz ms
dBm mV
kHz µs
dB µV

Hz ns
dB.. nV

The units keys close the data input and define the multiplication factor for each basic unit. For dimension-less or alphanumeric inputs, the units keys have weight 1. They behave, in this case, like the ENTER key.

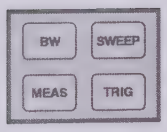
see Chapter 3

4

FREQ	Set frequency axis
SPAN	Set span
AMPT	Set level indication and configure RF input.
MKR	Select and set standard marker and delta marker functions.
MKR->	Change instrument settings via markers
MKR FCTN	Select further marker and delta marker functions

see Chapter 4

5



BW	– Set resolution bandwidth, video bandwidth and sweep time, – Set coupling of these parameters
SWEEP	Select sweep
MEAS	Select and set power measurements
TRIG	Set trigger sources

see Chapter 4

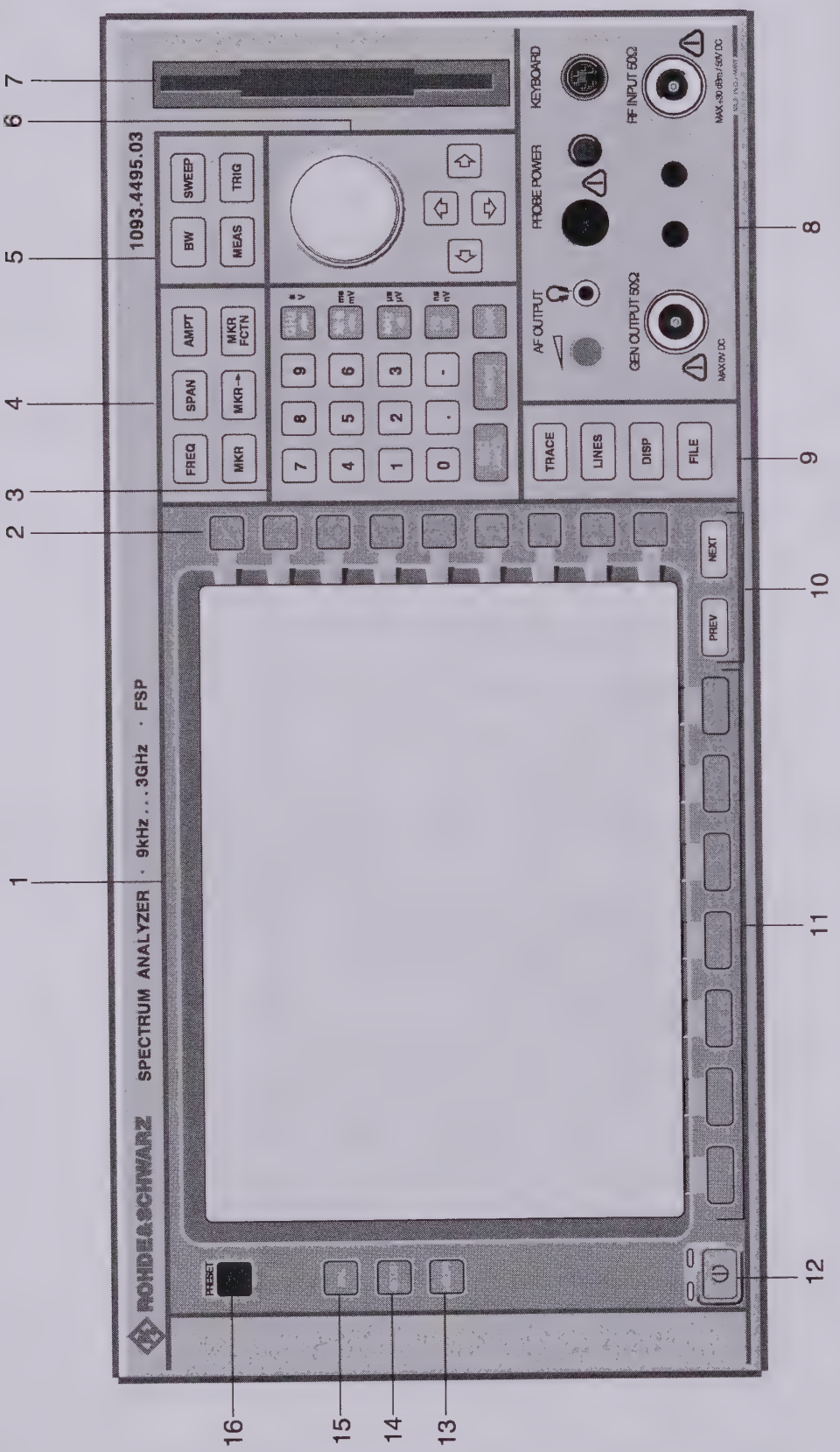
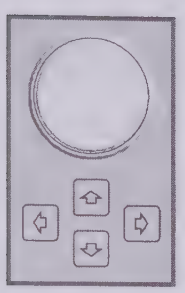


Fig. 1-1 Front View

6



Key group for entering data and for cursor movement — see Chapter 3

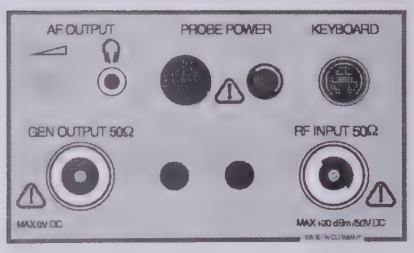
Cursor keys
- Move the cursor within the input fields and tables.
- Vary the input value.
- Define the direction of movement for the roll-key.

Roll-key
- Vary input values.
- Move markers and limits.
- Select letters in the help line editor.
- Move cursor in the tables
- Close data input (ENTER)

7

3 1/2" diskette drive; 1.44 MByte

8



AF OUTPUT (only with option FSP-B3) — see Chapter 8
- Volume control
- Head phone connector

PROBE POWER — Power supply and coded socket (+15 V/ -12 V) for accessories

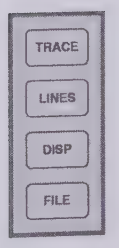
KEYBOARD — Connector for an external keyboard

RF INPUT — RF input — see Chapter 8

Caution:

The maximum DC voltage is 50 V, the maximum power is 1 W (≙ 30 dBm) at ≥ 10 dB attenuation.

9



TRACE — Select and activate traces and detectors — see Chapter 4

LINES — Set limit lines

DISP — Configure display

FILE
- Save and recall instrument data
- Configuration of memory media and data

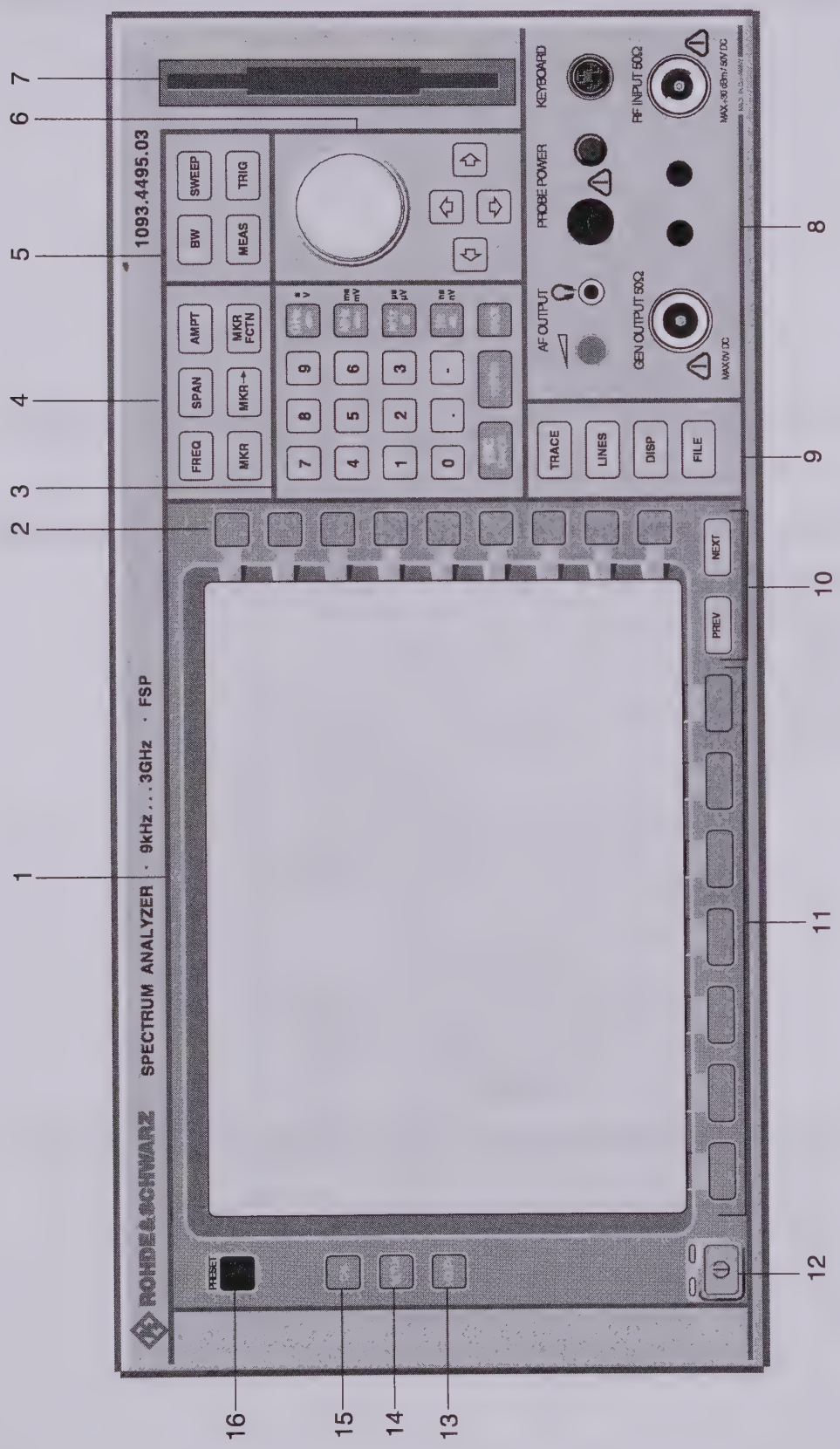
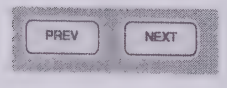


Fig. 1-1 Front View

10



Menu-change keys

NEXT Change to side menu

PREV Call main menu

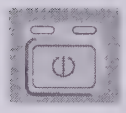
see Chapter 3

11

Hotkeys

see Chapter 3

12



ON/STANDBY switch

see Chapter 1

13

Configure and start a print job

see Chapters 1 and 4

14

Define general configuration

see Chapter 4

15

Record correction data

see Chapter 4

16

Call default settings

see Chapter 4

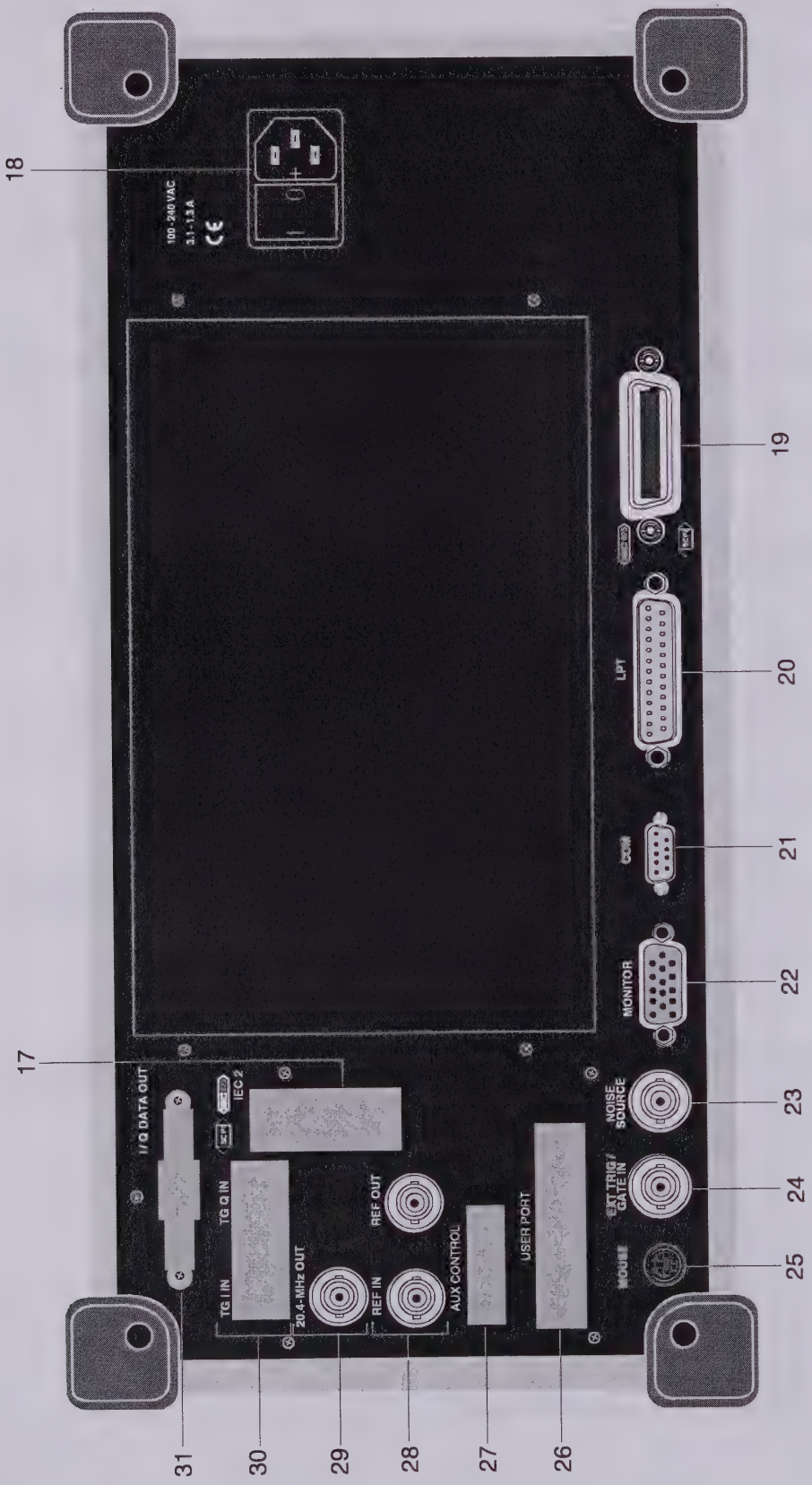


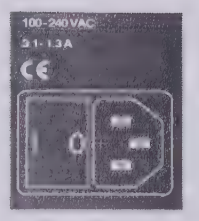
Fig. 1-1 Rear View

Rear View

17

Reserved for options — see Chapter 8

18

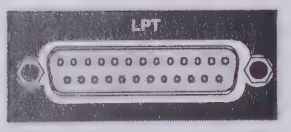


Power switch and AC power connector — see Chapter 1

19

IEC/IEEE bus-connector — see Chapter 8

20



Parallel interface connector (printer connector) — see Chapter 8

21

Connector for a serial interface (9-pin socket; COM) — see Chapter 8

22

Connector for an external monitor — see Chapter 8

23

Output connector for an external noise source — see Chapter 8

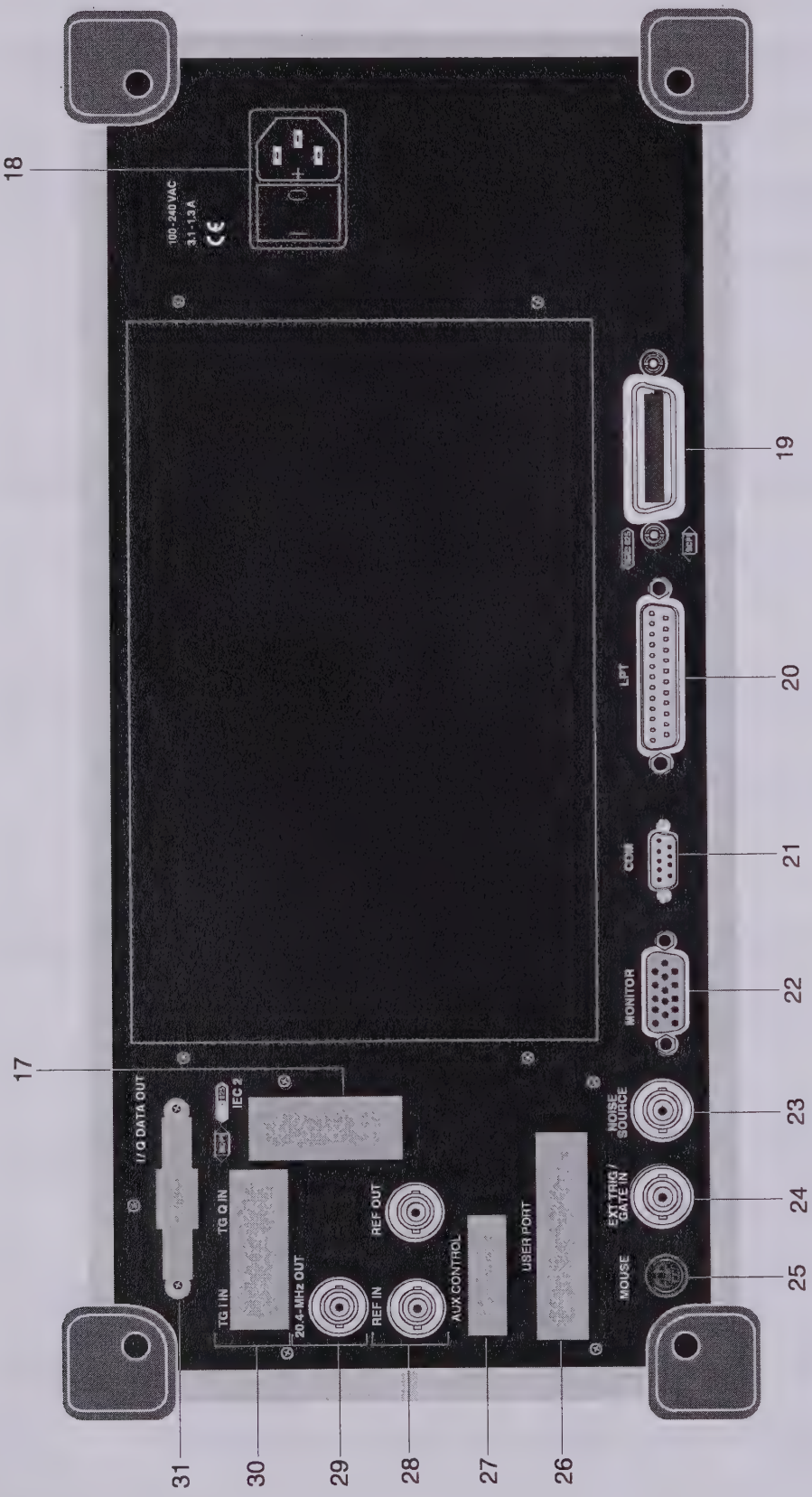


Fig. 1-2 Rear View

24

Input connector for an external trigger or an external gate signal

see Chapter 8

25

Connector for a PS/2 mouse

see Chapter 8

26

Reserved for options

27

Reserved for options

28

REF IN Input connector for an external reference (10 MHz)

REF OUT Output connector for an internal reference (10 MHz)

29

Output connector for 20.4 MHz IF

see Chapter 8

30

Reserved for options

31

Reserved for options

Putting into Operation

The following section describes how to put the instrument into operation and connect it to the AC supply and to external devices.
Chapter 2 explains the operation of the instrument using simple measurements as examples.

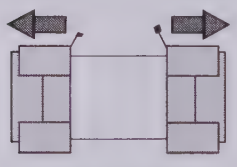
Important note:

Before turning the instrument on, it must be observed that the following conditions are fulfilled:

- *instrument covers are in place and all fasteners are tightened,*
- *fan openings are free from obstructions,*
- *signal levels at the input connectors are all within specified maximums,*
- *signal outputs are correctly connected.and not overloaded.*

Non-observance may cause damage to the instrument .

Putting into Operation



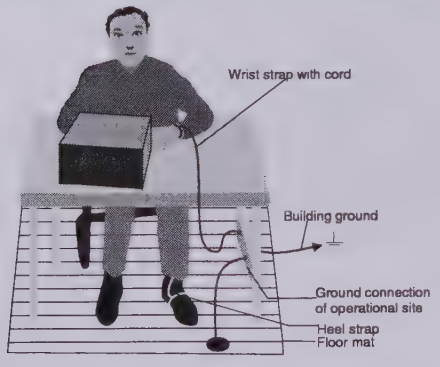
remove protective caps

- Take the instrument out of the shipping box and check whether the items listed in the packing list and in the lists of accessories are all included.
- Remove the two protective caps from the front and rear of the FSP and carefully check the instrument for damage.
- Should the instrument be damaged, immediately notify the forwarder which shipped the instrument to you and keep the box and packing material.
- For further transport or shipment of the FSP the original packing should also be used. It is recommended to keep at least the two protective caps for front and rear side in order to prevent damage to the controls and connectors.

Setting up the Instrument

Stand-alone Operation

The instrument is designed for use under general laboratory conditions. The ambient conditions required at the operational site are as follows:



- The ambient temperature must be in the range recommended in the data sheet.
- All fan openings must be unobstructed and the air flow at the rear panel and at the side-panel perforations must not be obstructed. The distance to the wall should be at least 10 cm.
- The mounting surface should be flat.
- To avoid damage of electronic components of the DUT and the spectrum analyzer, the operational site must be protected against electrostatic discharge.

Rackmounting

Important Note:

For rack installation, ensure that the air flow at the side-panel perforations and the air exhaust at the rear panel are not obstructed.

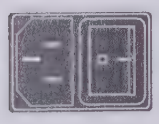
The instrument may be mounted in a 19" rack by using the rack adapter kit ZZA-95 (order number see data sheet). The installation instructions are included in the adapter kit.

EMI Protection Measures

In order to prevent electromagnetic interference (EMI), the instrument may be operated only when all covers are correctly in place. Only adequately shielded signal and control cables may be used (see recommended accessories).

Connecting the Instrument to the AC Supply

The FSP is equipped with an AC voltage selection feature and will automatically set itself according to the applied AC voltage (range: 100 to 240 VAC, 40 to 400 Hz). External switchover or adaptation of the fuses are not necessary. The AC power connector is located on the rear panel (see below).



Power connector

➢ Connect the instrument to the AC power source using the AC power cable delivered with the instrument.

As the instrument is designed according to the regulations for safety class EN61010, it must be connected to a power outlet with earthing contact.

Switching on/off the Instrument

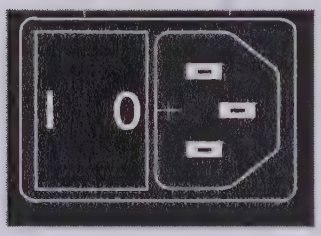
Caution:

Do not power down during booting. *Such a switch-off may lead to corruption of the hard disk files.*

When switching on the FSP, no disk should be inserted in the drive; otherwise, one of the actions stored on the floppy disk will be performed.

AC power switch on the rear panel

Power switch Power connector



Power switch

Position I = ON

In the I position, the instrument is in standby mode or in operation, depending on the position of the ON/STANDBY key at the front of the instrument.

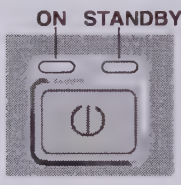
Note:

The AC power switch may remain ON continuously. Switching to OFF is only required when the instrument must be completely removed from the AC power source.

Position O = OFF

The 0 position implies an all-pole disconnection of the instrument from the AC power source.

ON/STANDBY switch on the front panel



Standby switch

The ON/STANDBY switch activates two different operating modes indicated by colored LEDs:

Operation ON - ON/STANDBY is depressed

The green LED (ON) is illuminated. The instrument is ready for operation. All modules within the instrument are supplied with power.

Caution:

In standby mode, the AC power voltage is present within the instrument

STANDBY - ON/STANDBY switch is not depressed.

The yellow LED (STANDBY) is illuminated. The DC power supply is supplied with power and the quartz oven is maintained at normal operating temperature.

Switching on the Instrument

- To switch on the FSP set the power switch on the rear to the position I
- Set the FSP to operating mode by pressing the *ON/STANDBY* key on the front once. The yellow LED (STANDBY) has to be illuminated.

Startup Menu and Booting

After switching on the instrument, a message on the installed BIOS version (eg Analyzer BIOS Rev. 1.2) appears on the screen for a few seconds.

Boot Windows NT first and then the device firmware. After booting, the instrument begins to measure. The type of measurement active prior to the last power-off is performed provided no other device configuration has been selected with *STARTUP RECALL* in the *FILE* menu.

Switching off the FSP

Proceed in the following order to switch off the FSP:

- ➢ Remove any disk from the drive.
- ➢ Set the ON/STANDBY key to standby mode by pressing once. The orange LED has to be illuminated.

Only when removing the FSP completely from the AC power source:

- ➢ Set the power switch at the rear to the 0 position.

Power-Save Mode

Display:

The FSP offers the possibility of switching on a power-save mode for the screen display. The screen is blanked out if no entry is made on the front panel (key, softkey or hotkey and rollkey) during the selected response time.

Switch on the power-save mode:

1. Call *DISPLAY - CONFIG DISPLAY* submenu to configure the screen display:
   - ➢ Press *DISP* key
   - ➢ Press *CONFIG DISPLAY* softkey

2. Activate the save mode
   - ➢ Press *DISPLAY PWR SAVE* softkey.
     The softkey is highlighted in colour, thus indicating that the power-save mode is on. At the same time the entry window for the response time is opened.

3. Define response time
   - ➢ Enter the required response time in minutes and confirm the entry with the *ENTER* key.
     The screen is blanked out after the selected time has elapsed.

Harddisk:

A power-save mode is preset for the built-in harddisk which is automatically closed down 15 minutes after the last access.

Battery-Powered Memory

The FSP is equipped with a battery-powered read/write memory (CMOS-RAM) where instrument settings are saved at power-off. After each power-on, the FSP is reloaded with the operational parameters which were active just prior to the last power-off (STANDBY or AC power OFF) or were set with STARTUP RACALL (see Chapter 4 "Saving and Recalling Data Sets").

A lithium battery is used to supply power to the CMOS-RAM. When the battery is depleted (expected life is approx. 5 years), any data stored in CMOS-RAM will be lost. In this case, the factory standard setup is loaded at turn-on. For changing batteries please contact the representative of our company responsible for you.

Functional Test

After turning on the AC power, the FSP returns the following message to the display screen:

Rohde & Schwarz GmbH & Co. KG
Analyzer BIOS Vx.y

After appearance of the above message, a self-test of the digital hardware is performed. Subsequently, the Windows NT controller boots and the instrument then starts measuring.

The system error correction is actived via *CAL* key, *CAL TOTAL* softkey. The individual results of the system error correction (PASSED / FAILED) can be displayed in the *CAL* menu.
With the aid of the built-in self-test functions (*SETUP* key, *SERVICE, SELFTEST* soft keys), the functional integrity of the instrument can be verified and/or defective modules can be localized.

Windows NT

Caution:

The drivers and programms used in Windows NT are adapted to the measuring instrument. In order to prevent damage to instrument functions, only the settings described below should be resorted to. The existing software should be modified only with the update software released by Rohde&Schwarz. Programs released by Rohde&Schwarz should be run exclusively on the instrument.

Do not power down during booting. *Such a switch-off may lead to corruption of the hard disk files.*

The instrument runs under the operating system Windows NT. The computer can be used to configure and install the device drivers released by Rohde&Schwarz. Other applications are authorized only under the conditions described in this operating manual.

Login

Windows NTrequires a login window in which the user is asked to identify himself by entering his name and password. An autologin comes as standard in the instrument, ie the login is performed automatically in the background. The user name used for this is "instrument" and the password is also "instrument" (in small letters).

Administrator function

The function with which the instrument performs the autologin contains the administrator rights.

After an installation, which is usually possible only with administrator rights (eg the installation of new printer drivers), Service Pack 5 of Windows NT has to be re-installed. This is indicated at the corresponding place. The installation of the Service Pack is described in the section "Installation of Windows NT Software".

Calling the Windows NT start menu

The Windows NT start menu is called using the combination of keys <CTRL> <ESC>. It is possible to access to the required submenus from the start menu by means of the mouse or the cursor keys. On activating the window "R&S Analyzer Interface" on the computer, a return can be made to the measurement mask.

Connecting an External Keyboard

Caution:
The keyboard may only be connected when the instrument is switched off (STANDBY). Otherwise, correct operation of the keyboard cannot be guaranteed.

The FSP offers a 6-contact PS/2-connector KEYBOARD on the instrument front panel for the connection of an external PC. It is recommended to use keyboard PSP-Z1 (Order No. 1091.4000.02, German) or PSP-Z2 (Order No. 1091.4100.02, English). They are fitted with a trackball for mouse control.

During measurement operations, the keyboard simplifies the input of commentary text, filenames, etc.

The section "Instrument Interfaces" in Chapter 8 contains the interface description of the connector.

After connection the keyboard is automatically recognized. The default setting is for the US keyboard. Special settings such as repetitional rate etc. can be performed in Windows NT menu START - SETTINGS - CONTROL PANEL - KEYBOARD.

Connecting a Mouse

Caution:
The mouse may only be connected when the instrument is switched off (STANDBY). Otherwise, correct operation of the mouse and instrument cannot be guaranteed.

In order to ease operation of Windows NT, the FSP provides an option for connecting a mouse to a PS/2 mouse (MOUSE) connector.
The Microsoft mouse is the supported mouse type and is available under option PS-B1 (order number 1006.6359.02). The mouse connectors are located on the rear panel.

Note. *The recommended keyboard PSP-Z1/2 is fitted with a trackball for mouse control. Connecting a separate mouse in addition may impair correct operation.*

The section "Instrument Interfaces" in Chapter 8 contains the interface description of the connector.

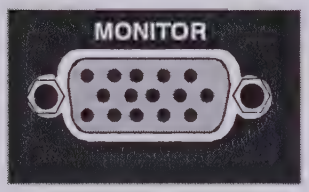
After connection the mouse is automatically recognized. Special settings such as mouse cursor speed etc., can be performed in the Windows NT menu START - SETTINGS - CONTROL PANEL - MOUSE.

Connecting an External Monitor

Caution:
The monitor may only be connected when the instrument is switched off (STANDBY). Otherwise, the monitor may be damaged.

Do not modify the screen driver (display type) and display configuration since this would disturb instrument operation.

The instrument is fitted with a rear-panel connector MONITOR for the connection of an external monitor.



After connecting the external monitor the measurement screen is displayed on both the external monitor and the instrument. Further settings are not necessary.

Connecting an Output Device

Caution:
The output device may be connected only when the instrument is switched off (STANDBY)

Note: *When installing printer drivers that are not pre-installed in the instrument, the operator is requested to insert the disk with the new driver into drive A.*
After installation the Service Pack should be re-installed (see section "Installation of Windows NT Software")

The instrument provides an option for connecting up to three different output devices to allow printing a hard copy of the display screen. The *DEVICE* table in menu *HCOPY – DEVICE1/2* indicates the available installed output devices (see also Chapter 4, section "Documentation of Test Results").

The interface connectors are located on the rear panel:

Chapter 8 contains the interface descriptions of the connectors.

After connection of the output device to the appropriate interface connector, the configuration of the interface as well as the output device must be entered and the output device must be assigned to the interface.

1. Connecting the keyboard and the mouse

For the installation and configuration of printer drivers on the FSP, it is necessary to connect a keyboard to the front panel and a PS/2 mouse to the rear panel (only in case of using a keyboard without trackball, see sections "Connecting a Mouse" and "Connecting a Keyboard").

2. Switching to Windows NT start menu and opening the system control

The combination of keys <CTRL><ESC> is used to switch to the Windows NT start menu. The system control is then opened in the NT start menu using the sequence SETTINGS - CONTROL PANEL.

3. Configuration of the interface

LPT	Interface LPT cannot be configured.
COM	The configuration of serial interface COM can be performed either in the Windows NT menu START - SETTINGS - CONTROL PANEL - PORTS or in the FSP SETUP - GENERAL SETUP menu. The parameters *Baud Rate*, *Data Bits*, *Parity*, *Stop Bits*, *Flow Control* determine the transmission parameters of the interface They must agree with the specifications of the output device (see the operating manual for the output device). To print out via the COM interface, the latter must first be assigned the controller function in the SETUP - GENERAL SETUP menu (owner = OS).

Note: *Allocation of the instrument (Owner = Instrument) in the menu SETUP - GENERAL SETUP makes the interfaces available for remote control. The settings made in the menu SETUP - GENERAL SETUP overwrite the settings in the NT menu..*
However, settings in the Windows NT menu do not overwrite those of the SETUP menu. This means that the settings are only valid as long as the interfaces are allocated to the controller

4. Selection and installation of the printer driver

The selection and installation of the printer driver, the assignment to the interface and the setting of most of the printer-specific parameters (eg paper size) is performed under Windows NT in the START - SETTINGS - PRINTER menu.

5. Configuration of the connected output device

The configuration of the connected output device and the assignment to the interface takes place in the *HCOPY DEVICE1/2* menu (see in Chapter 4, the section "Measurement Documantation"). The configuration of up to two output devices (DEVICE1 and DEVICE2) may be entered, of which, at least one must be activated for printing.

- The parameter *DEVICE* determines which output device is to be used.
- The parameter *PRINT TO FILE* determines if the output is in the form of a file.
- The parameter *ORIENTATION* sets the page format to horizontal or vertical (portrait).

Selecting the type of printer automatically sets the parameters *PRINT TO FILE* and *ORIENTATION* to values which correspond to a standard mode with this output device. Other printer-dependent parameters such as *FORMFEED*, *PAPERFEED* etc., can be modified under Windows NT in the printer properties window (START/SETTINGS/PRINTER/SETTINGS/....).

Table 1-1 shows the standard factory settings for the two output devices.

The factory settings of DEVICE 1 correspond to output format "WMF" (Windows Metafile), printing is performed in a file. WMF is a common format which is used for the import of hardcopies (eg measurement windows) to other Windows applications that support this format (eg WinWord).

The factory setting of DEVICE 2 is "Clipboard". In this setting the printout is copied to the Windows NT clipboard. Most of Windows applications support the clipboard. The clipboard content can be directly inserted in a document via EDIT - PASTE.

Table 1-1 Factory settings for *DEVICE 1* and *DEVICE 2* in the *HCOPY* menu.

Parameter	**Parameter Name**	***DEVICE 1 Settings***	***DEVICE 2 Settings***
Output Device	DEVICE/LANGUAGE	WINDOWS METAFILE	CLIPBOARD
Output	PRINT TO FILE	YES	---
Paper Format	ORIENTATION	---	---

In the following example, a HP DeskJet 660C printer is connected to interface LPT and configured as *DEVICE2* of the instrument to output hardcopies of the measurement screen.

Switch off FSP.

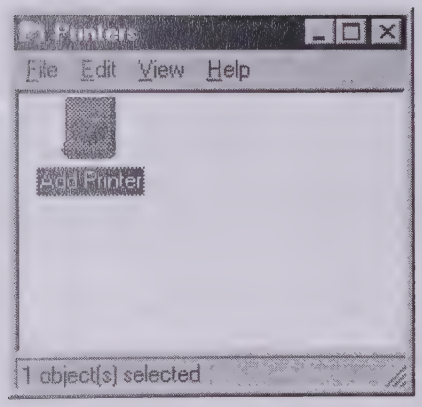
Connect printer to interface LPT.

Switch on FSP and printer.

Select printer driver under Windows NT

➢ Press key combination <CTRL> <ESC>

The Windows NT menu is displayed.

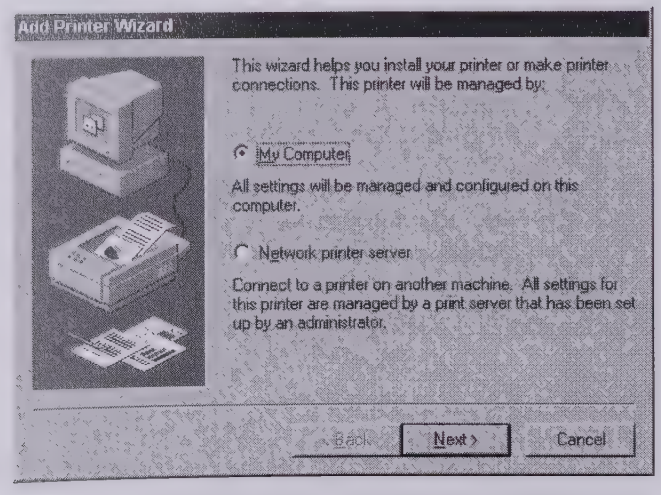


➢ In the Start menu press first "Setting" and then "Printers".

The printer window is opened.

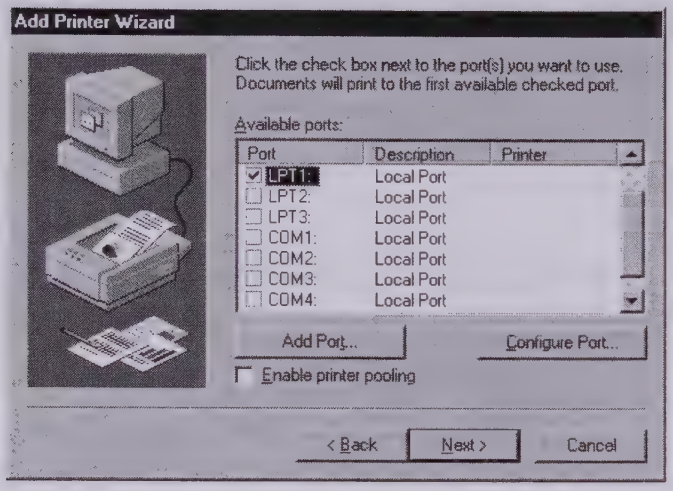
➢ Double-click symbol "Add Printer".

The "Add Printer Wizard" window is opened. This window leads through the following printer driver installation.


Add Printer Wizard
This wizard helps you install your printer or make printer connections. This printer will be managed by:
My Computer
All settings will be managed and configured on this computer.
Network printer server
Connect to a printer on another machine. All settings for this printer are managed by a print server that has been set up by an administrator.
< Back
Next >
Cancel

➢ Click first "My computer" and then "Next".

The available ports are displayed.

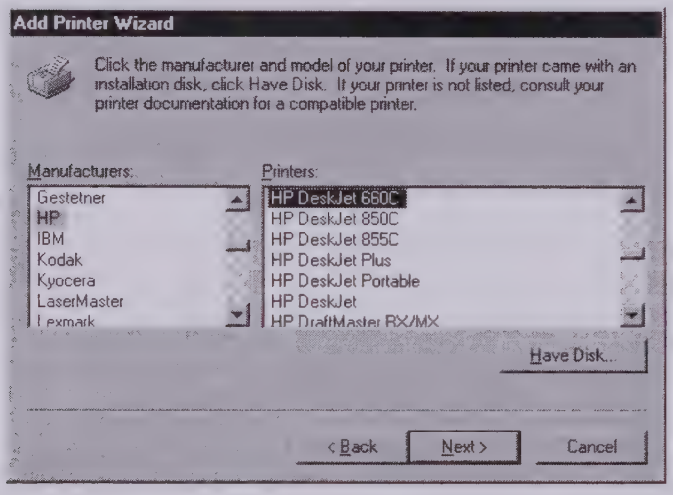


➢ Select LPT1 port.

The selection is marked by a tick.

➢ "Click "Next".

The available printer drivers are displayed. The left-hand selection table indicates the manufacturers and the right-hand one the available printer drivers.

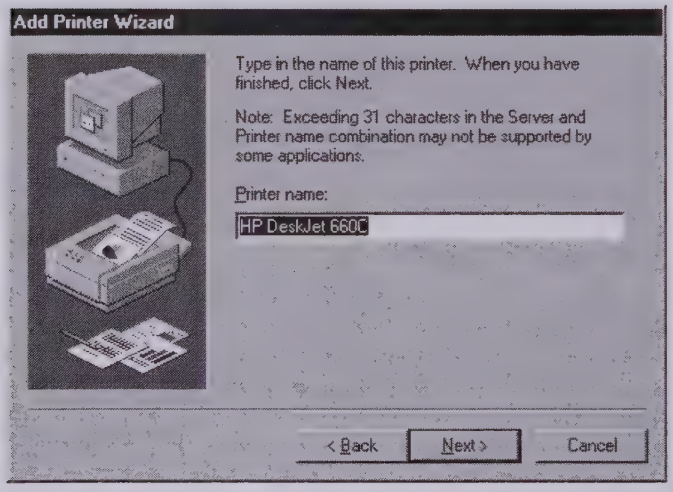


➢ Mark "HP" in selection table "Manufacturers" and "HP DeskJet 660C" in selection table "Printers".

Note:
If the type of the output device required is not included in the list, the driver has not yet been installed. Click on button "HAVE DISK". The operator is now requested to insert a disk with the corresponding printer driver. Then press OK and select the required printer driver. After installation, Service Pack 5 should be re-installed (see section "Installation of Windows NT Software")

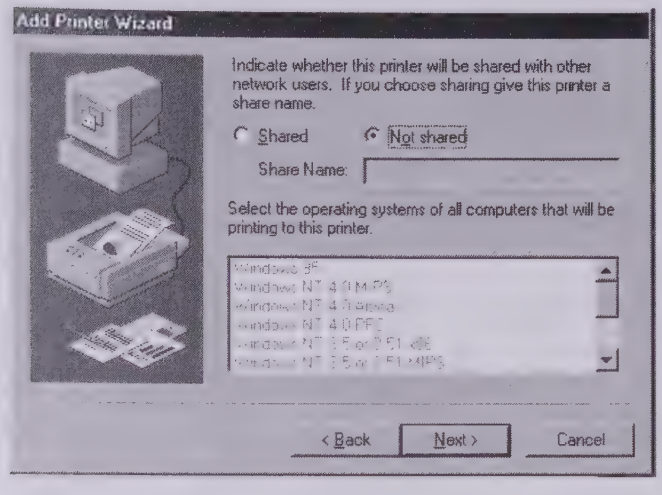
➢ Click "Next".

The entry field for the printer name is displayed.


Add Printer Wizard
Type in the name of this printer. When you have finished, click Next.
Note: Exceeding 31 characters in the Server and Printer name combination may not be supported by some applications.
Printer name:
HP DeskJet 660C
< Back
Next >
Cancel

➢ The printer name can be modified in the entry field "Printer name" (max. 60 characters).

If one or more printers are already installed, a query is displayed in this window to ask if the printer last installed as default printer should be selected for the Windows NT applications (Do you want your Windows-based programs to use this printer as default printer?) "No" is preset.

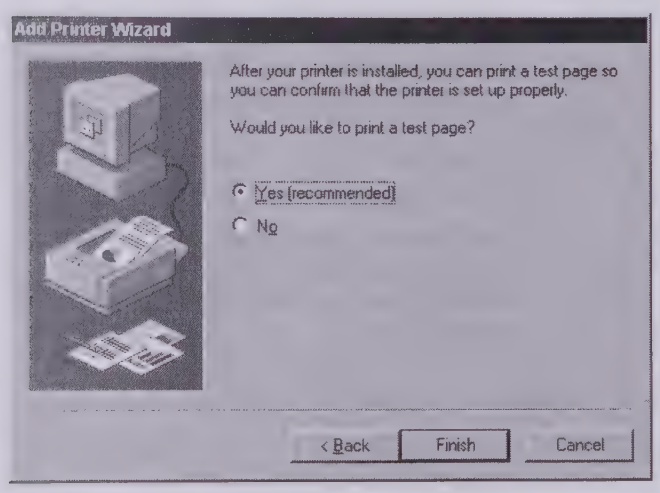

Add Printer Wizard
Indicate whether this printer will be shared with other network users. If you choose sharing give this printer a share name.
Shared
Not shared
Share Name:
Select the operating systems of all computers that will be printing to this printer.
< Back
Next >
Cancel

➢ "Click "Next".

A query is displayed for providing the printer in the network. This query is irrelevant when installing a local printer. The answer "Not shared" is preset.

➢ Click "Next".

The window for starting a test page is displayed. The test page is for checking if the installation was successful.


Add Printer Wizard
After your printer is installed, you can print a test page so you can confirm that the printer is set up properly.
Would you like to print a test page?
Yes (recommended)
No
< Back
Finish
Cancel

➢ Click Yes (recommended)".

➢ Click "Finish".

A test page is printed out if the installation was successful.
If the test page is not printed out or not completely, the Windows NT online help offers troubleshooting instructions under the entry "Printer Trouble Shooting".

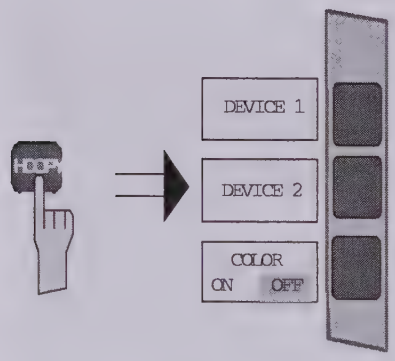
Note:
If the operator is requested to specify the path for the printer driver after clicking "Finish", he should re-install the Service Pack after this printer installation (see Chapter 1, section "Controller Function - Installation of Windows NT Software").

The instrument has to be configured with this printer for the printout of the measurement screen.

Configuring HP DeskJet 660C.

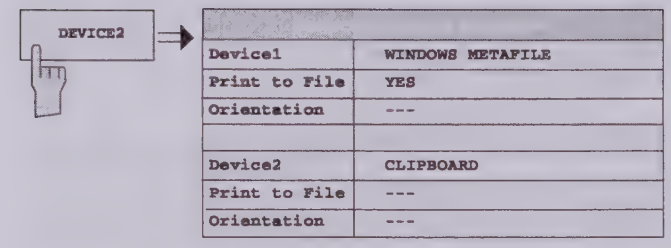
➢ Click button "R&S Analyzer Interface".

The measurement screen is displayed.



➢ Press the *HCOPY* key.

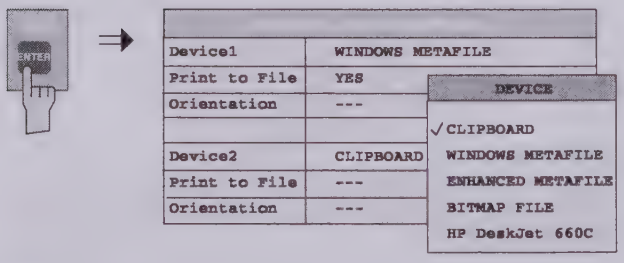
The *HCOPY* menu is opened.



➢ Press the *DEVICE2* softkey.

DEVICE 2 is activated.

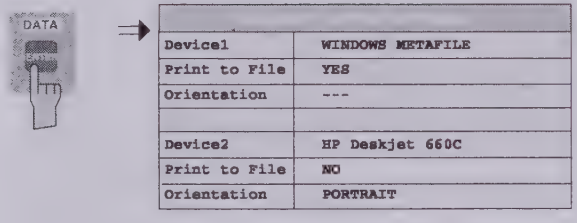
The *HARDCOPY DEVICE SETTINGS*-Table is opened and the current settings of the two output devices are indicated. The current selection in line DEVICE2 is highlighted by the selection bar.



➢ Press one of the unit keys.

The selection box *DEVICE* is displayed on the screen. The current selection is marked by a tick and highlighted by the selection bar.

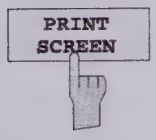
➢ Press cursor key ⇩ until the entry *HP DeskJet 600C* is highlighted by the selection bar.



➢ Press the ENTER key.

The selection box *DEVICE* is closed and *HP DeskJet 660C* is entered in line *DEVICE2*.

Note:
Selecting the type of printer automatically sets the parameters PRINT TO FILE and ORIENTATION to values which correspond to a standard mode with this output device. Other printer-dependent parameters such as PAPERSIZE, can be modified under Windows NT in the printer properties window (START/SETTINGS/PRINTER/SETTINGS).



Start print of measurement results

➢ Press Softkey *PRINT SCREEN* to start the print job.

Installing Windows NT Software

The driver software and the system settings of Windows NT are exactly adapted to the measurement functions of the instrument. Correct operation of the instrument can therefore be guaranteed only if the software and hardware used is released or offered by Rohde & Schwarz.
The use of other software or hardware may cause malfunctioning or failures in the functions of the FSP
A current list of released software can be obtained from your nearest Rohde&Schwarz agency (see list of addresses).

After installing the software of other manufacturers from a disk, it is necessary to re-install Service Pack 5 of Windows NT:

Re-installing Service Pack 5

➢ In the Start menu press first "Setting" and then "Run".

The entry window is opened.

➢ Enter "C:\SP\SP5I386E.EXE" into the command line and start installation with "OK".

The following window leads through the installation.

Contents - Chapter 2 "Getting Started"

2 Getting Started

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Level and Frequency Measurements – Example 1 ..... 2.1
Level and Frequency Measurements – Example 2 ..... 2.7
Measurement of Harmonic Separation **2.9**
Measurement Task 2.9
Measurement Procedure - Harmonic Separation 2.10

2 Getting Started

Chapter 2 presents basic measurements performed by a spectrum analyzer to provide fast and easy access to the operation of the instrument.

Before starting any measurement with the FSP, please note the instructions given in chapter 1 for putting the instrument into operation. In chapters 3 you will find detailed information on customizing the instrument and the display.

For a systematic explanation of all menus, functions and parameters and background information refer to the reference part in chapter 4.

All of the following examples assume the standard settings for the analyzer. These are set with the *PRESET* key. A complete listing of standard settings can be found in Chapter 4, Section "Preset settings of the FSP – *PRESET key*".

Level and Frequency Measurements

Measurement Task

The determination of the level and frequency of a signal is one of the most frequently encountered measurement tasks typically performed by a spectrum analyzer. Usually, for the measurement of an unknown signal, the PRESET settings are initially selected. If levels above +30 dBm are expected or possible, then a power attenuator must be inserted ahead of the analyzer input. Without attenuation, these signal levels might damage or destroy the input attenuator or the input mixer.

Important Spectrum Analyzer Functions

Important parameters for level and frequency measurements are the settings for the center frequency (*CENTER*), the selection of the active measurement frequency range (*SPAN*) and the *MARKER* functions.

Level and Frequency Measurements – Example 1

In this example, a signal with a frequency of 200 MHz and a level of -30 dBm are applied to the RF INPUT of the analyzer. The selection of the center frequency and the active frequency range takes place manually.
The necessary setup functions are mainly performed by the fixed-function keys. The menus which appear with a key can, for the most part, be ignored. In this manner, fast, key-oriented operation is possible.

The following setup steps are performed:

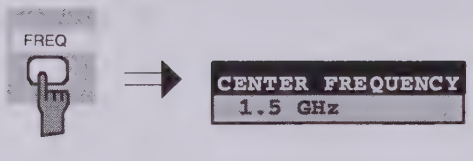
1. Reset the instrument.
2. Apply the test signal.
3. Set the center frequency to 200 MHz.
4. Reduce the active measurement frequency range (SPAN) to 1 MHz.
5. Measure the level and frequency using the marker.
6. Optimize the measurement dynamic range and reduce the level measurement error.
7. Measure the frequency with the internal frequency counter

1. Reset the instrument.

➢ Press the *PRESET* key.

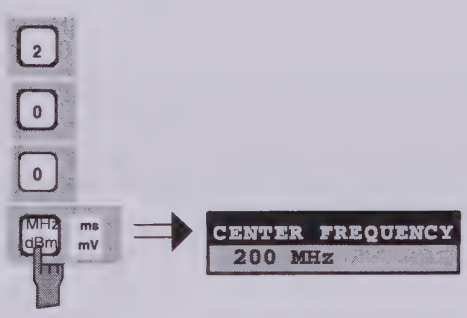
2. Connect the test signal to the RF INPUT located on the instrument front panel.

3. Set the center frequency to 200 MHz.



➢ Press the *FREQ* key.

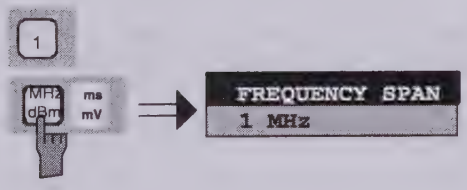
The input field for center frequency appears on the display screen.



➢ Enter *200* via the numeric keypad and terminate with the *MHz* key.

4. Reduce the measurement frequency range (SPAN) to 1 MHz.

➢ Press the *SPAN* key.



➢ Enter *1* via the numeric keypad and terminate with the *MHz* key.

Note: *In conjunction with the change in measurement frequency range (SPAN), the resolution bandwidth (RES BW), video bandwidth (VIDEO BW) and sweep time (SWEEP TIME) are set to new values since they are defined as coupled functions in the standard PRESET settings.*

5. Measure level and frequency using the marker and read the resulting values on the display screen.

➢ Press the *MKR* key.

The marker jumps to the largest signal peak shown on the display screen.

Note: *When the marker is switched on for the first time, it automatically performs the PEAK SEARCH function as demonstrated in this example.*
If a marker was already active, the PEAK softkey in the MRK-> menu must be pressed in order to set the currently active marker to the displayed signal maximum.

The level and frequency measured by the marker can be read in the marker field at the upper edge of the display screen.(see Fig. 2-1).

➢ Using the roll-key, the marker can be moved along the measured curve.

The corresponding level and frequency values appear in the marker field.

Fig. 2-1 shows the measured curve on the display screen over a 1 MHz range as well as the marker level and frequency values.

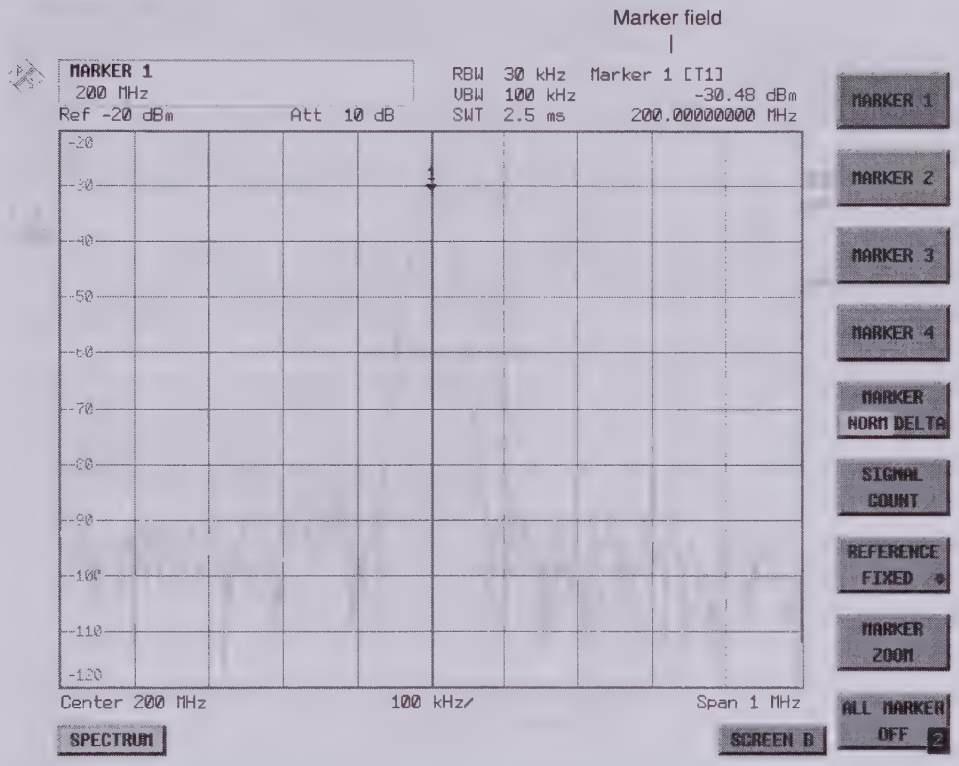
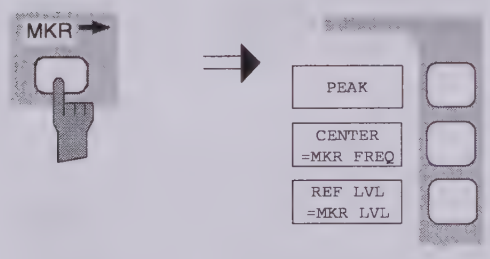


Fig. 2-1 200-MHz signal. The measured values are displayed in the marker field.

At low signal-to-noise ratios, the level measurement accuracy can be improved by an optimum selection of the FSP parameters. The accuracy of the frequency display can also be enhanced by applying the internal frequency counter.



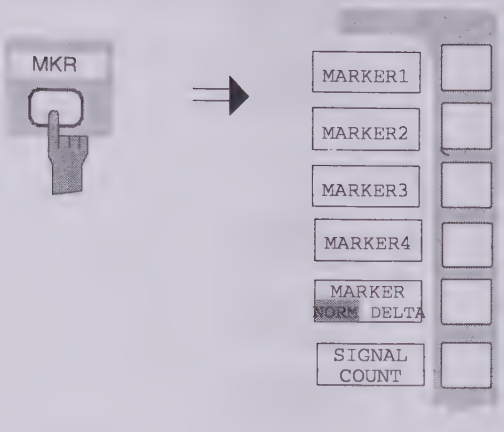
6. Optimize the dynamic range and reduce the level measurement error.

➢ Press the *MKR→* key.

The *MKR→* menu is opened.

➢ Press *REF LVL = MKR LVL* soft key.

The reference level (REF LEVEL) is reduced to the signal level.



7. Determine the exact frequency with the internal frequency counter.

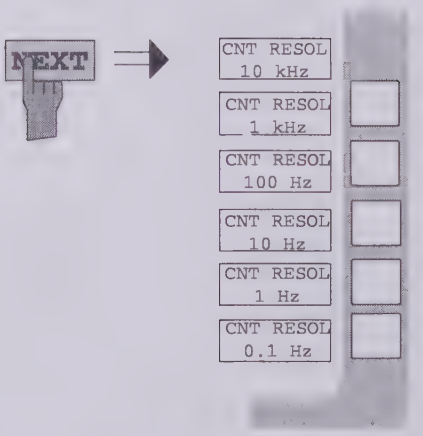
Note: *The frequency counter measures the frequency of the marked signal with the selected counter resolution and at the accuracy of the internal frequency reference. A frequency measurement made using the marker is, however, limited by the number of horizontal display points and the applicable resolution bandwidth.*

➢ Press the *MKR* key.

The *MARKER* menu is opened.

➢ Press the *SIGNAL COUNT* soft key.

The internal frequency counter is now active and measures the signal frequency with the PRESET resolution. The resolution is to be increased to 10 Hz.



➢ Press the menu change key *NEXT*.

The right side menu is opened.

➢ Press the *10 Hz* soft key.

The desired frequency resolution (10 Hz) is now selected.

In the marker field, the item [CNT] indicates that the counter is active (see Fig. 2-2).

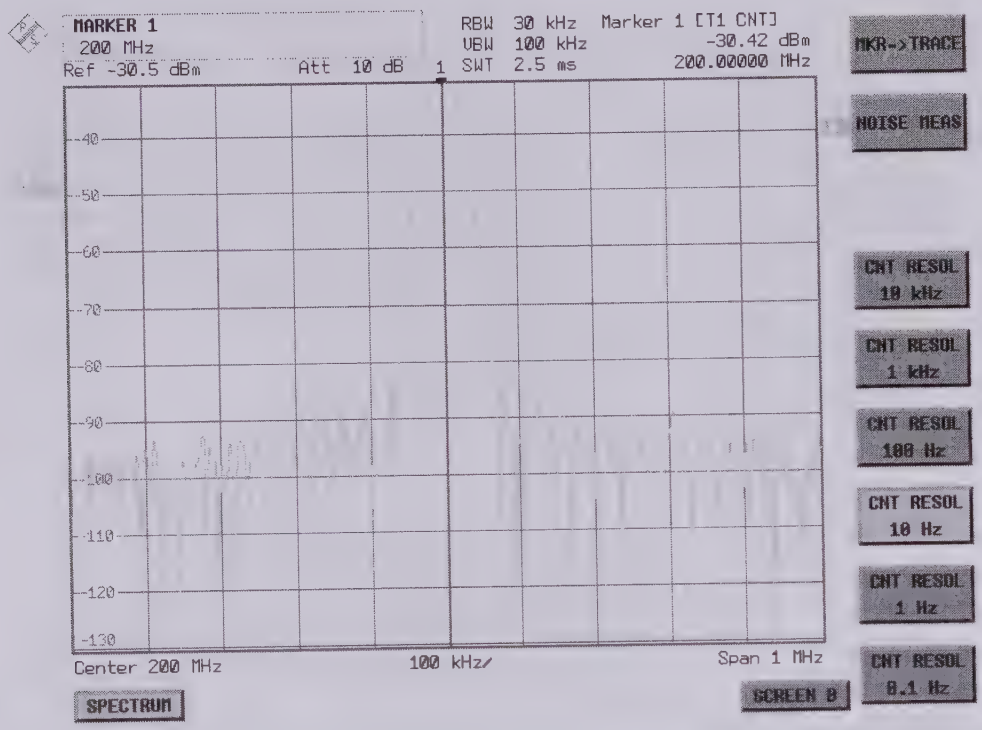


Fig. 2-2 Frequency measurement using the internal frequency counter.

Level and Frequency Measurements – Example 2

The zoom function (*MARKER ZOOM*) operates much faster than the manual input of center frequency and measurement frequency range, and permits the measurement frequency range displayed on the screen to be as narrow as desired.

As in Example 1, a signal with a frequency of 200 MHz and a level of -10 dBm is applied to the analyzer RF INPUT.

The following setup steps are performed:

1. Reset the instrument.
2. Apply the signal.
3. Zoom in on the signal.
4. Measure the level and frequency with the marker.
5. Optimize the dynamic range and reduce the level measurement error.
6. Measure the frequency with the internal frequency counter.

Steps 1 to 2 and 4 to 6 correspond to steps 1 to 2 and 5 to 7, respectively, of Example 1. Step 3 replaces the manual input of center frequency and measurement frequency range. (steps 3 and 4).

See steps 1 and 2 of example 1

1. Reset the instrument to standard settings.

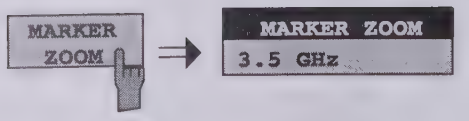
2. Connect the test signal to the analyzer RF INPUT.

---

3. Zoom in on the signal.

➢ Press the *MKR* key

The marker moves to the largest signal displayed on the screen. In this example, it is the signal at 200 MHz. (PEAK SEARCH function, see step 5 in Example 1).



➢ Press the *MARKER ZOOM* soft key.

The input field for the measurement frequency range appears on the display screen.

➢ Enter 1 via the numeric keypad and terminate with the *MHz* key.

After entry of the measurement frequency range, the marked signal is counted and then used as the new center frequency. At the same time, the entered measurement frequency range is set.

Note: *In conjunction with the active measurement frequency range (SPAN) change, the resolution bandwidth (RES BW), video bandwidth (VIDEO BW) and sweep time (SWEEP TIME) are also set to new values since they are defined as coupled functions in the standard PRESET settings.*

See steps 5 to 7 of example 1:

4. ***Read the values for level and frequency as measured by the marker.***
5. ***Optimize the dynamic range and reduce the level measurement error.***
6. ***Determine the frequency with the internal frequency counter.***

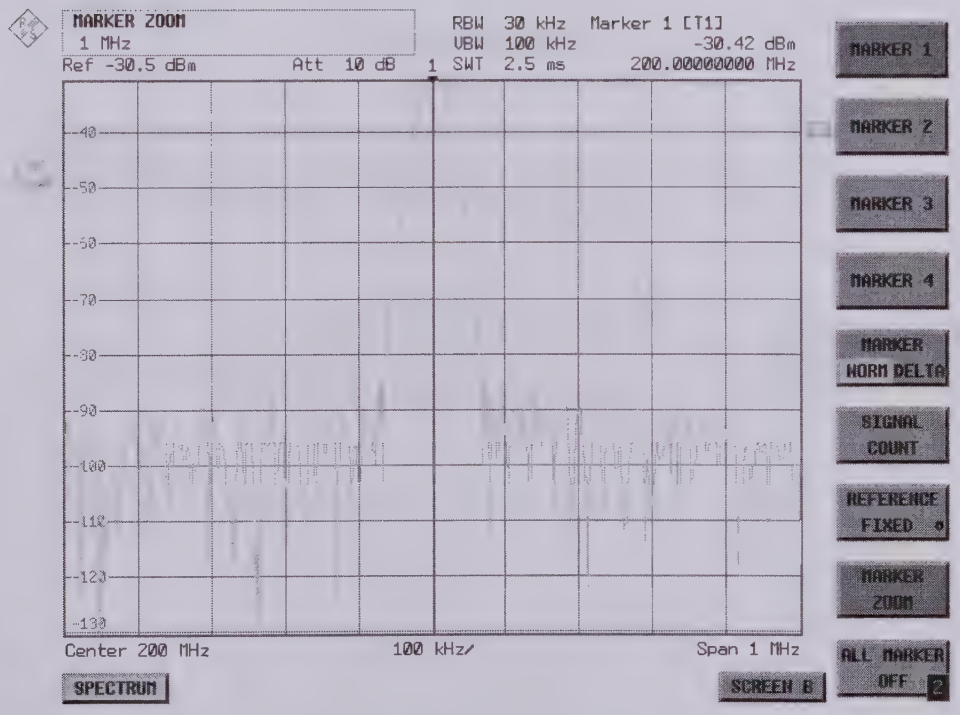


Fig. 2-3 The MARKER ZOOM function requires the entry of the span

Measurement of Harmonic Separation

Measurement Task

The measurement of signal harmonics is a frequently occurring task which can be optimally performed by a spectrum analyzer. In general, all signals will contain harmonics to some degree. Harmonics are especially critical in high-power transmitters, e.g., in radio transmitters, where a significant radiated harmonic component may interfere with the reception of other radio services.

Generally, non-linear device characteristics create harmonics which are often selectively reduced through the use of low-pass filters. Since the spectrum analyzer also has non-linear characteristics, e.g., at the first mixer, it is necessary to exercise caution during a measurement to insure that the spurious harmonics generated by the analyzer do not influence the measurement results. If necessary, the fundamental frequency must be selectively attenuated with respect to the harmonics by insertion of an appropriate high-pass filter.

For harmonic-content measurements, the achievable measurement dynamic range is dependent upon the k2 intercept of the spectrum analyzer. The k2 intercept point is defined as the fictitious first-mixer input level where the levels of the first harmonic and of the fundamental frequency are equal. In practice, this level cannot be applied to the mixer since, to do so, would cause its destruction. However, using the k2 intercept point concept, the achievable measurement dynamic range for the harmonics of a Unit Under Test (UUT) can be calculated with relative simplicity.

As can be seen in Fig. 2-4, the harmonic level is reduced by 20 dB when the level at the fundamental frequency is reduced by 10 dB.

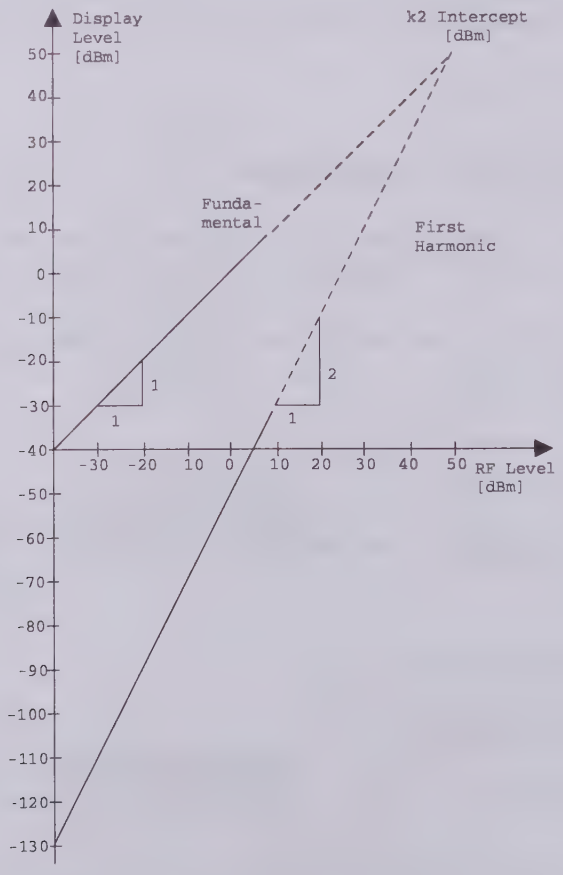


Fig. 2-4 Theoretical display curve of fundamental and first harmonic with a k2 intercept of 50 dBm.

From the linear equations and the given intercept point, the following formula can be derived for the achievable harmonic separation a_{k2} in dB:

$$a_{k2} = IP2 - P_e \qquad (1)$$

a_{k2} = harmonic separation
P_e = mixer level/dBm
IP2 = k2 intercept point

The formula for the internally produced level P_1 at the first harmonic in dBm is:

$$P_1 = 2 \bullet P_e - IP2 \qquad (2)$$

The lower harmonic measurement limit is dictated by the noise figure of the spectrum analyzer. Through adequate averaging with the video filter, the UUT harmonic level which is to be measured should be at least 4 dB over the noise figure so that the measurement error caused by the input noise is less than 1 dB.

From the above, the following rules for the measurement of large harmonic separations can be derived:

- Select an IF bandwidth as narrow as possible in order to reduce the noise figure.
- Select the RF attenuation as high as required so that the necessary harmonic separation can still be measured.

The maximum harmonic separation is achieved when the harmonics level is equal to the inherent noise level of the receiver. The corresponding level at the mixer according to (2) is:

$$P_e[dBm] = \frac{P_{noise} / dBm + IP2}{2}$$

For a 30 Hz resolution bandwidth, (noise level < -140 dB, IP2 = 50 dBm), this level is -45 dBm. Therefore, according to (1) , the maximum measurable harmonic separation is 95 dB less 4 dB minimum signal-to-noise ratio.

Measurement Procedure - Harmonic Separation

In addition to frequency and level settings, the harmonic separation measurement requires, above all, the delta markers. The fundamental and harmonic signals are measured in one measurement frequency range.

A 10 MHz reference signal with a level of 7 dBm is used at the input signal to the analyzer front-panel RF INPUT. The reference level must be set to 10 dBm.

The following setup steps are performed:

1. Reset the instrument.
2. Set the reference level to 10 dBm.
3. Connect the 10 MHz reference signal to the analyzer input RF INPUT.
4. Set the start frequency to 5 MHz.
5. Set the stop frequency to 55 MHz.
6. Smooth the displayed noise with the video bandwidth.
7. Measure the fundamental signal with the marker.
8. Measure the harmonic separation with the delta marker.
9. Measure the separation of remaining harmonics.

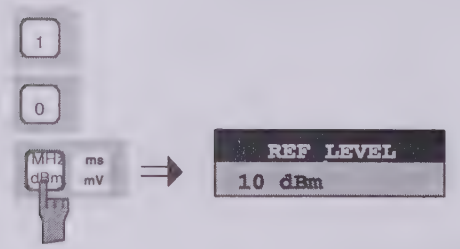
1. Reset the analyzer.

➢ Press the *PRESET key.*

2. Set the reference level to 10 dBm.

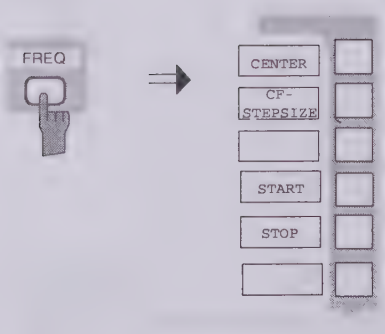
➢ Press *AMPT* key.

The entry field for the reference level appears on the display screen.



➢ Enter 10 via the numeric keypad and terminate with the *dBm* key.

3. Connect the 10 MHz-reference signal to the analyzer RF INPUT.



4. Set the start frequency to 5 MHz

➢ Press the *FREQ* key.

The *FREQ* menu is opened.

➢ Press the *START* softkey.

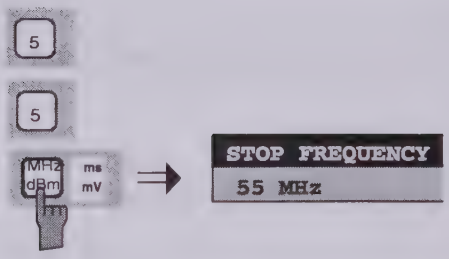
The entry window for the start frequency appears on the display screen.

➢ Enter 5 via the numeric keypad and terminate with the *MHz* key.

Set the stop frequency to 55 MHz

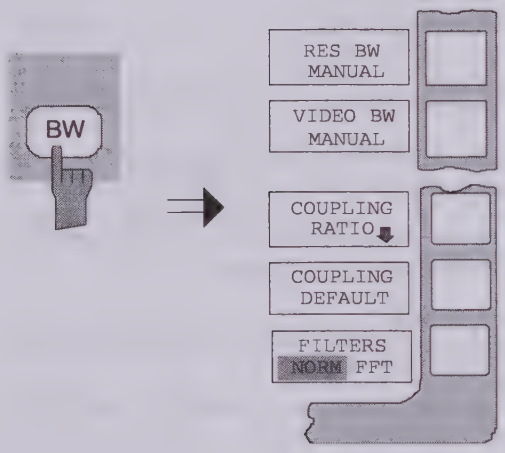
➢ Press the *STOP* softkey in the *FREQ* menu.

The entry window for the stop frequency appears on the display screen.



➢ Enter 55 via the numeric keypad and terminate with the *MHz* key.

6. Smooth the displayed noise with the video bandwidth



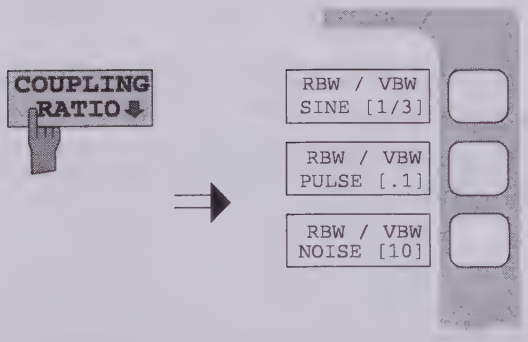
➢ Press the *BW* key.

The *BW* menu is opened.

The video bandwidth can now be either automatically coupled to the resolution bandwidth or manually entered.

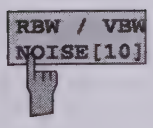
either:

Automatic coupling of the video bandwidth to the measurement frequency range



➢ Press the *COUPLING RATIO* soft key.

The sub-menu for setting the automatic coupling of bandwidths to the measurement frequency range is opened.

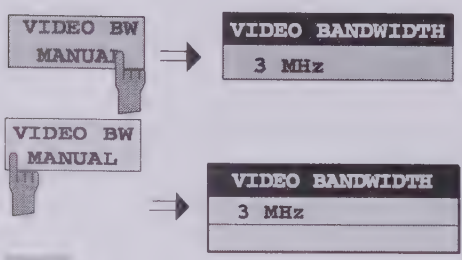


➢ Press the *RBW / VBW NOISE* soft key *[10]*.

The video bandwidth is set to a factor of 10 less than the resolution bandwidth. This smoothes the displayed noise.

➢ Press the menu change key *PREV*.

The *COUPLING RATIO* submenu is closed.

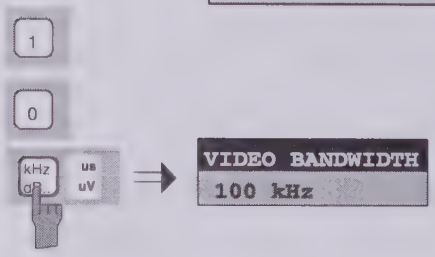


or:

Manual input of the video bandwidth

➢ Press the *VIDEO BW MANUAL soft key.*

The entry field for the video bandwidth appears on the display screen.



Enter 100 via the numeric keypad and terminate with the *kHz* key.

Measure the fundamental with the marker.

➢ Press the *MKR* key.

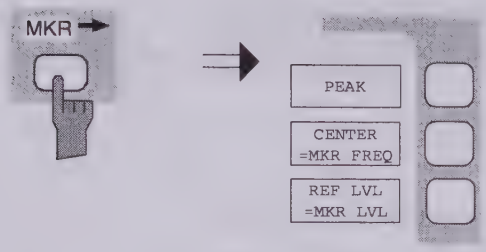
The marker appears at the fundamental peak (see also level and frequency measurement step 5 of the PEAK SEARCH function).

The measured values can be read at the upper right of the display screen.

8. Activate the delta marker and measure the harmonic separation

➢ Press the *MARKER 2* softkey in the *MKR* menu.

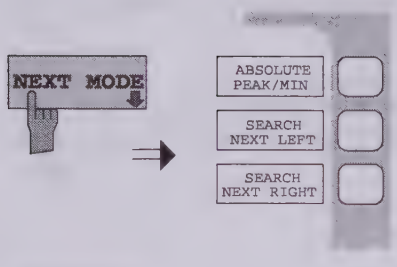
Marker 2 is active as delta marker. It jumps to the first harmonic and measures the difference between the harmonic and the fundamental. The measured values can be read at the upper left of the display screen. In this example, the harmonic separation is approx. 40 dB (see Fig. 2-5).



9. Measure the separation of additional harmonics

➢ Press the *MKR->* key.

The *MKR-> menu is opened.*



➢ Press the *NEXT MODE* .

The *NEXT MODE* submenu is opened..

➢ Press the *SEARCH NEXT RIGHT* soft key.

➢ Press the menu change key *PREV.*

The *NEXT MODE* menu is closed.

➢ Press the *NEXT PEAK* soft key.

The delta marker jumps to the next highest harmonic. The measured value can be read as before.

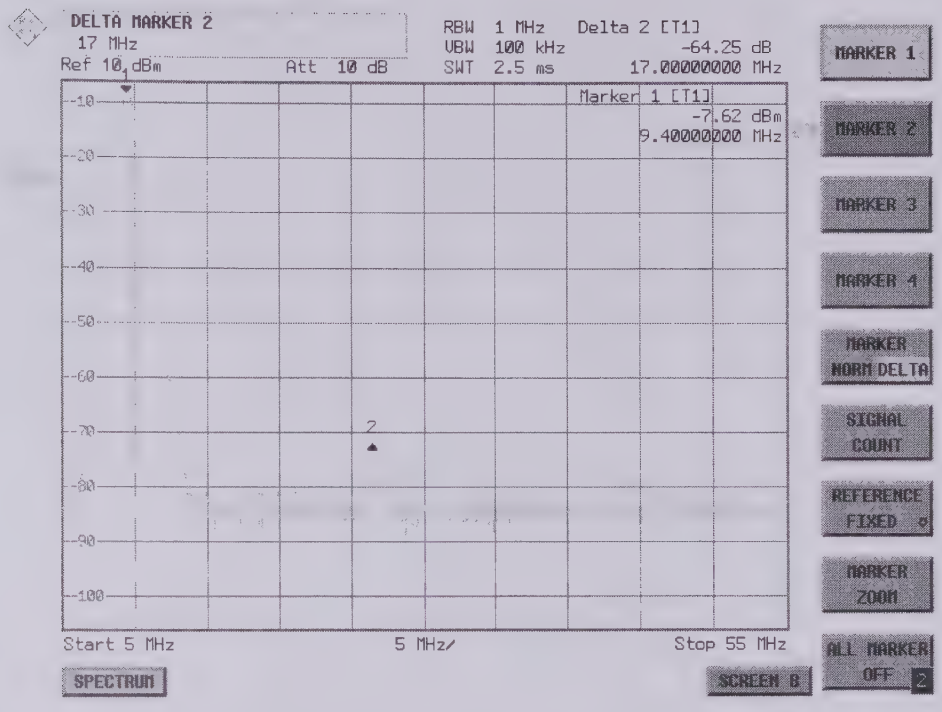


Fig. 2-5 First harmonic separation: approx. 60 dB referred to the fundamental

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3 Manual Operation

Chapter 3 provides an overview of the operating concept and the basic steps of manual operation of the FSP. This includes a description of the screen, of the control of menus and of the setting of parameters. An overview of the menus will be listed at the end of this chapter.

The functions of the menus are described in dtail in Chapter 4. Chapter 2 contains a short introduction on step-by-step simple measurements. The remote control of the instrument is described in Chapters 5, 6 and 7

The operation of the spectrum analyzer is menu-controlled via keys, hotkeys and softkeys. The setting of the instrument and test parameters in the menus is made either directly via softkeys or by entry of values in entry fields and by selection in tables. The operating mode and the screen mode is selected via the hotkeys.
If required, data entry windows and tables are superimposed on the screen.

The Screen

The screen informs continuously on the results and parameters of the selected measuring functions. It shows the assignment of the softkeys and menus, which are required for setting the measuring parameters. The display of test results, the softkey labeling and the type of menu depend on the selected measuring function.
The screen is subdivided into three areas:

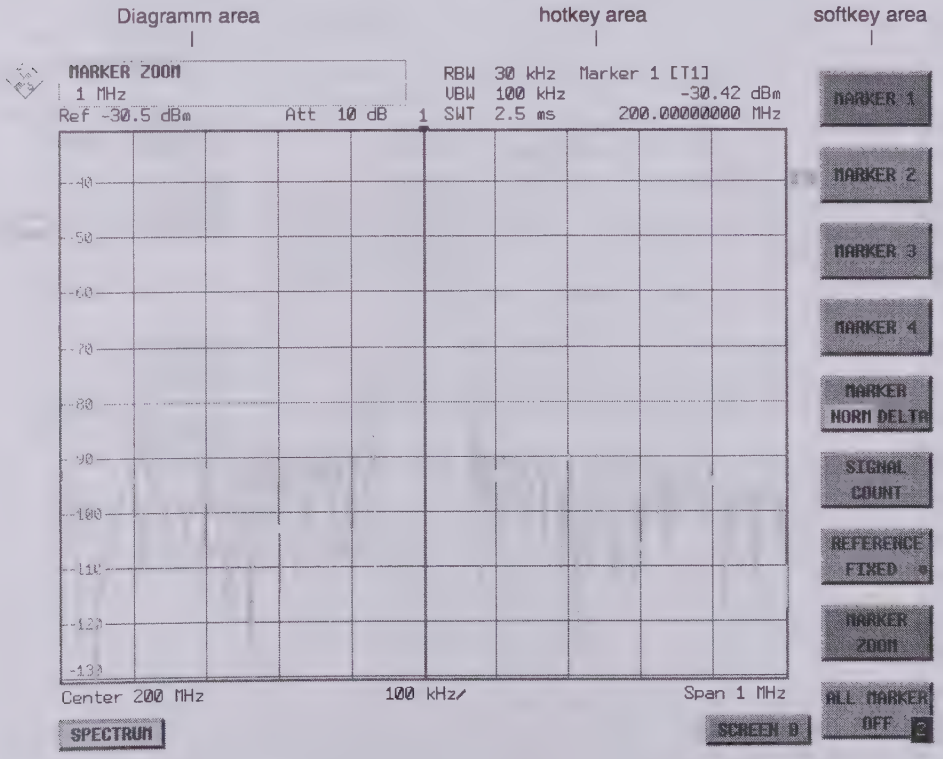


Fig. 3-1 Subdivision of screen

Diagram area This area contains the measuring diagrams and other measured-value information as well as the parameters and status information which are important for analysis of the results.
In addition, message fields, entry windows and tables may be shown in this area.

Softkey area This area contains the instrument functions which can be selected via the softkeys. The softkey area is not superimposed by other graphics.

Hotkey area This area contains the available operating modes and screen modes. The hotkey area is not superimposed by other graphics.

Diagram Area

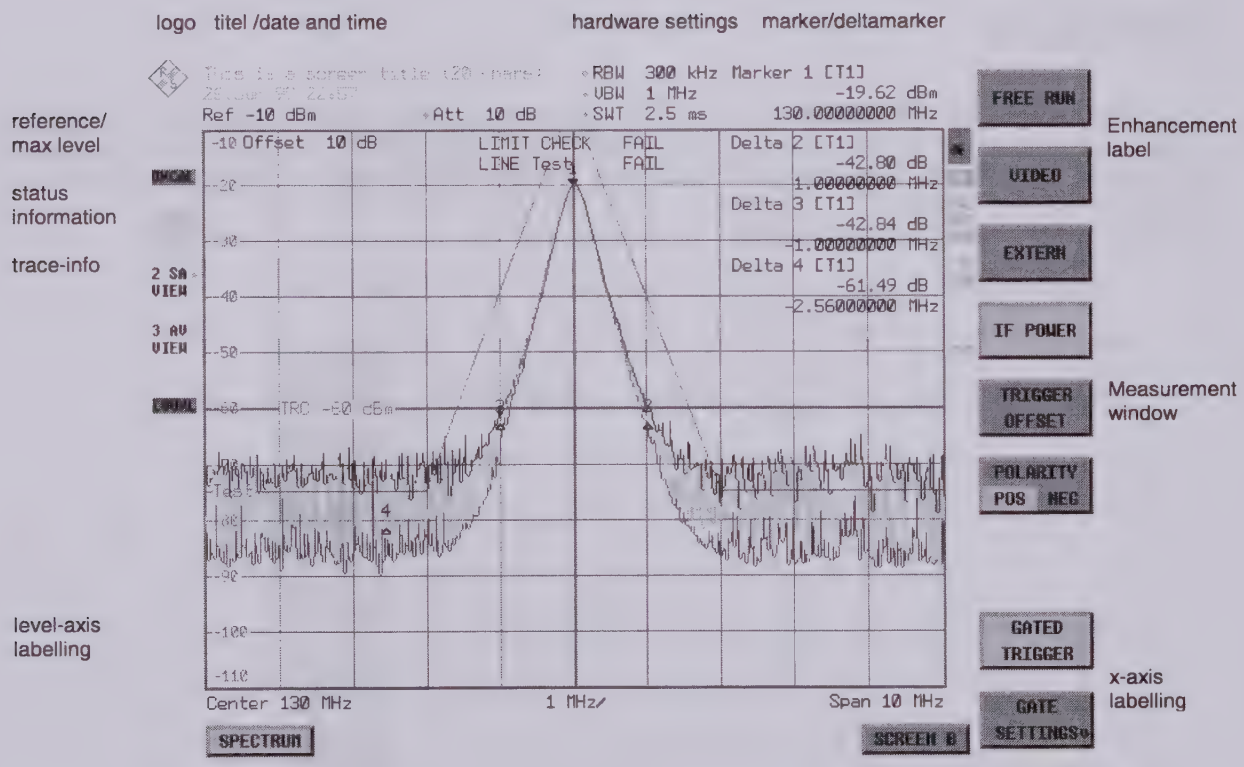


Fig. 3-2 Subdivision of the FSP screen in analyzer mode (without measuring diagram)

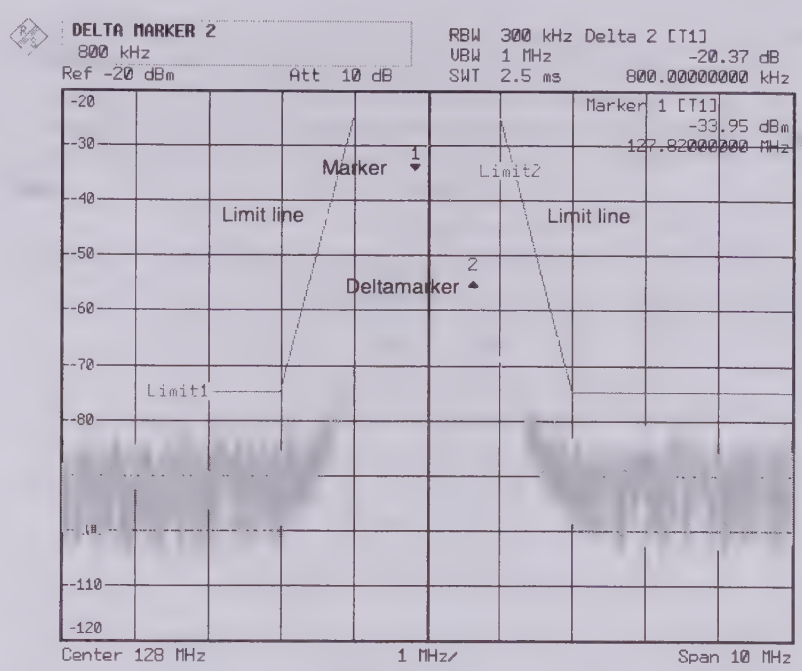


Fig.3-3 Measuring diagram

Indications in the Diagram Area

The following graphic elements are displayed in the diagram area:

General indications Indication of the logo

Logo

Screen title Indication of selected screen title

Date / time Indication of date and time

Hardware settings

Ref Indication of the reference level

Offset Indication of the offset of reference level.

Att Indication of the set RF attenuation.

RBW Indication of the set resolution bandwidth.
If the bandwidth does not correspond to the value of the automatic coupling, a green asterisk "*" is prefixed to the field.

VBW Indication of the set video bandwidth.
If the bandwidth does not correspond to the value of the automatic coupling, a green asterisk "*" is prefixed to the field.

SWT Indication of the set sweep time.
If the sweep time does not correspond to the value of the automatic coupling an asterisk "*" is prefixed to the field. The colour of the asterisk turns red as soon as the sweep time falls below the value of the automatic coupling.

Marker/deltamarker

This label displays the position of the last selected marker or deltamarker in the x and y-directions and the marker/deltamarker index. The square brackets contain the curve which the marker is assigned to and the active measuring function of the marker indicated. The measuring function of the markers in the second field is indicated by the following abbreviations:

FXD	reference fixed active
PHN	phase noise measurement active
CNT	frequency counter active
TRK	signal track active
NOI	noise measurement active
MOD	measurement of AM modulation depth active
TOI	TOI measurement active (3rd order intercept)

Limit check

Indication of the result of the limit check.

X-axis labelling

Display of the x-scaling.

`10 MHz/DIV`

The distance between two grid lines is displayed in this label.

`Center 1.2345678901234 GHz`

`Start 1.2345678901234 GHz`

The set center frequency or start frequency is displayed in this label depending on whether the keys FREQ/SPAN or the softkeys START/STOP were last pressed.
If span = 0 Hz, the center frequency is always displayed.

`Span 1.2345678901234 GHz`

`Stop 1.2345678901234 GHz`

`Trigger 1.234 ms`

The set frequency range (*SPAN*) or the stop frequency is displayed, depending on whether the keys FREQ/SPAN or the softkeys START/STOP were last pressed.
If span = 0 Hz, the trigger moment (*PRETRIGGER*) is displayed.

Status information

The status information on the left side of the diagram hint at irregularity (e.g. UNCAL)

UNCAL

"UNCAL" is indicated under the following circumstances:

- correction data are switched off (menu CAL, CAL CORR OFF).
  ⇒ switch on CAL CORR ON or PRESET
- no valid correction data. This may occur after a cold start of the instrument following a firmware update.
  ⇒ record correction data
- Sweep time too short for current instrument settings (span, resolution bandwidth, video band width).
  ⇒ increase sweep time

OVLD / IFOVL

OVLD is indicated when the input mixer is overloaded.
⇒ Increase input attenuation

IFOVL is indicated when overload occurs in the IF signal path after the input mixer.
⇒ Increase reference level

MSG / LOUNL

MSG is indicated if a failure has occurred which impair correct measurement. The exact error message can be queried in the menu *SETUP SERVICE INFO*. The display disappears after the cause for the error has been eliminated.

LOUNL is indicated when an error occurs in the frequency processing of the instrument.

OVEN

OVEN is indicated when the crystal oscillator (option FSP-B4) has not yet reached its operating temperature. This indication vanishes after a few minutes after switch on.

Trace info:

Every active measurement curve (trace ≠ BLANK) is allocated a trace info of two or three lines at the left of the diagram. The trace info has the same colour as the measurement curve.

<n> <detector> <*>
<mode>
<trace math>

Example:

```
1 PK *
CLRWR
1-2
```

n = trace number (**1 ... 3**)

detector = selected detector
- **AP:** AUTOPEAK detector
- **PK:** MAX PEAK detector
- **MI:** MIN PEAK detector
- **SA:** SAMPLE detector
- **AV:** AVERAGE detector
- **RM:** RMS detector
- **QP:** QUASIPEAK detector

* = indicates that the selected detector does not correspond to that of the automatic coupling.

mode = indication of sweep mode
- **CLRWR:** CLEAR/WRITE
- **MAXH:** MAX HOLD
- **MINH:** MIN HOLD
- **AVG:** AVERAGE
- **VIEW:** VIEW

Trace math = trace math active
- **1 - 2** trace 1 - trace 2
- **1 - 3:** trace 1 - trace 3

Instrument settings
(Enhancement Labels)

Indication of user instrument settings which influence the measuring result and which are not immediately obvious when viewing the measured values.

***** The current instrument setting does not correspond to the one which applied when one of the displayed curves had been stored. This occurs under the following circumstances:

- The instrument setting is modified while a measurement is being performed.
- The instrument setting is modified in SINGLE SWEEP mode subsequent to the end of the sweep and no new sweep is started.
- The instrument setting is modified after setting the trace to VIEW.

The display is retained until the cause is eliminated by the user. I.e., either a new sweep is started (SINGLE SWEEP mode), or the trace of interest is switched to BLANK.

A / B Identification for screen A / B. When screen A / B is activated for the entry of test parameters, this label is highlighted.

SGL The sweep is set to SINGLE SWEEP.

GAT The frequency sweep is controlled via the *EXT TRIG/GATE* input of the instrument.

TRG The instrument is not triggered in *FREE RUN* mode.

LVL A level offset ≠ 0 dB has been set.

FRQ A frequency offset ≠ 0 Hz has been set.

PRN A printer output is active.

75 Ω The input impedance of the instrument is set to 75 Ω.

EXT The instrument is configured for operation with external reference

Entry fields:

Entry window The data entry window is superimposed in the left upper corner of the diagram area, if required. It covers the display of the title and the time. The field is used to enter numeric or alphanumeric device parameters.

Tables The tables are superimposed in the diagram area, if required. Sie dienen der Anzeige und Konfiguration von Geräteparametern.

Message windows:

Message field

Message fields provide notes on measurements, e.g. results of the limit check (PASS/FAIL).
These notes are no error messages, which are indicated as system messages.

They can be masked out by pressing the *ESC* key.

System messages

System messages indicate warnings and error messages.

Message without action field:
These system messages contain only arbitrary information. They hint at events which are of interest for the user but do not affect the measurement or functioning of the instrument.

They are deleted either automatically after a predefined time has passed (3 seconds) or upon any keystroke or mouse click.

Message with action field:
These system messages require a decision to be taken by the user. They are not deleted until any action has been selected. Deletion of the message initiates the action selected and appropriate measures to be taken. The action field consists of one (OK), two (OK/CANCEL) or three (arbitrary) buttons.
The user may select one of the buttons using the cursor keys and initiate the associated action by means of the unit keys. The ESC key is used to acknowledge the message without releasing any action.

Traces:

1 to 3

Up to 3 traces in each measurement diagram can be displayed simultaneously.

Limit lines

Limit lines are used to mark level curves or spectral distributions which must not be exceeded or dropped below.

The FSP provides two display modes:

- Full Screen: 1 window, the measurement is performed in the active diagram.
- Split Screen: 2 windows, the measurements are performed in both diagrams.

Full Screen

In the full-screen mode, the settings and measurements are performed in the active visible window. All indications on the screen refer to this window. The designation (SCREEN A or SCREEN B) is inserted as enhancement label A or B on the right diagram margin.
Switching between the windows is by means of *SCREEN A/B* hotkey. The current measurement is terminated when its window is blanked out.
Switching from split-screen to full-screen mode is performed in menu *DISP*.

Split Screen

In Split Screen mode, the screen is divided into two halves.

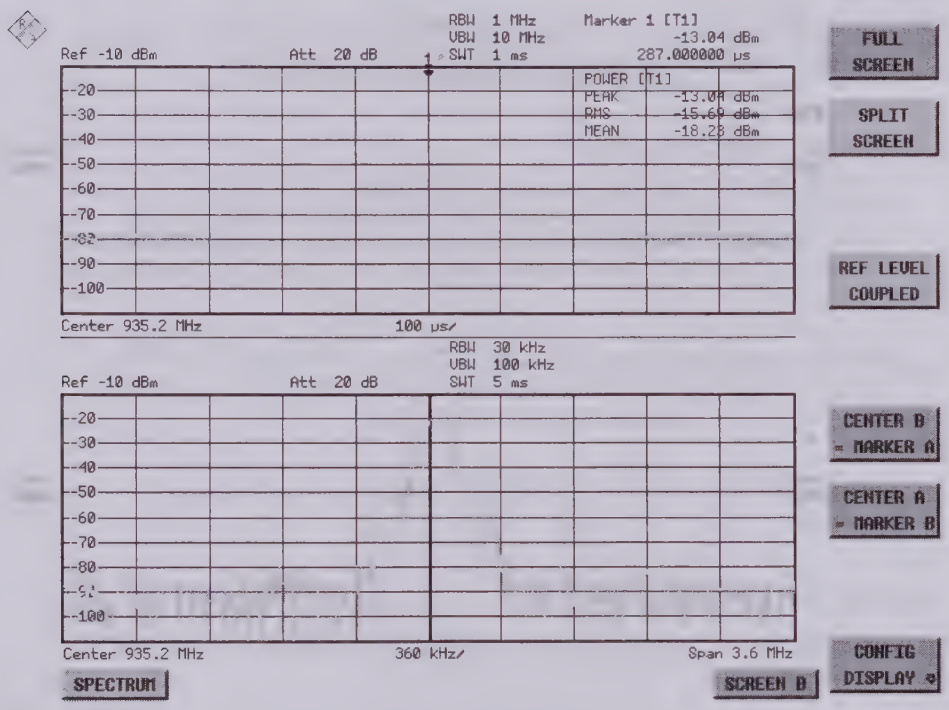


Fig.3-4 Subdivision of the screen in Split Screen mode

The upper half is assigned Screen A, the lower one Screen B. The settings for measurement can be selected independently for both screens. E.g., a spectrum may be displayed in Screen A and a time amplitude in the time range is displayed in Screen B.

The indications which are valid only for one window appear in the margin of the associated diagram. Indications which are valid for the two windows are displayed between the diagrams.

The window for entry of the measuring parameters or the marker operation is selected using the *SCREEN A/B* hotkey. The measurements are simultaneously performed in the two windows irrespective of the currently active one.
Switching from full-screen to split-screen mode is performed in menu *DISP*.

Softkey Area

The softkeys are assigned to the nine keys on the right side of the display
The setup of the softkey area is independent of the operating mode. It consists of the following graphic elements:

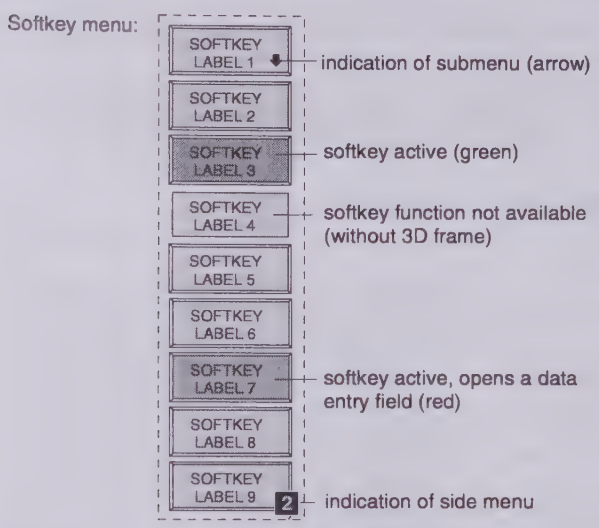


Fig.3-5 Setup of the softkey area

The softkeys have different functions depending on the instrument state. Therefore, their labeling can be varied. The labeling of all softkeys which call a submenu includes a ⇓ arrow.
The function and current state of the softkeys is indicated in the label by different texts and colors. The color assignment is factory-set as follows:

Table 3-1 Factory-set color assignment of soft keys

Softkey color	Meaning
gray	Softkey switched off
green	Softkey switched on
red	Softkey switched on and data entry active

These colors can be changed by the user as desired in the *DISP - CONFIG DISPLAY* menu.

A softkey is switched on or off by pressing the respective hardkey (see following section "Setting the Parameters").

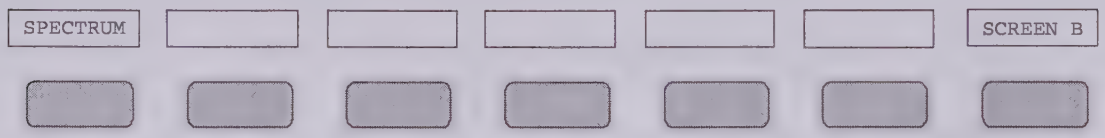
Softkeys are masked out, too, if the functionality which they represent is not available. A distinction has to be made between two cases:

- If an instrument function depends on an option, and if this option is not fitted, the associated softkey is masked out,.
- If the instrument function is not available temporarily due to specific settings, the softkey is displayed without the 3D frame.

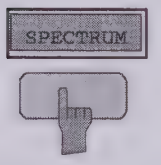
The label 2 on the right lower corner of the softkey area indicates that a side menu is available. The side menu is called by pressing the *NEXT* key.

Hotkey Area

Hotkeys are allocated to the eight keys on the bottom margin of the screen. They change between modes and the active diagrams.
The menu only shows the hotkeys which are actually used:



A keystroke activates the associated hotkey. An activated hotkey changes its frame:



Calling and Changing the Menus

The operation of the spectrum analyzer is menu-controlled via keys and softkeys. Various softkey menus are displayed depending on the instrument status. The individual menus constitute the so-called menu tree. The top menu (the root of the menu tree) is always called by means of a keystroke. Arrows at the lower edge of the softkey area indicate whether a supplementary menu can be entered or not.
Softkeys with an arrow allow for branching into further menus (so-called submenus): The field "2" at the lower right side of the softkey area indicates that this menu has a side menu.

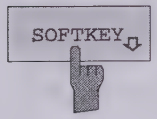
The menu change keys on the front panel below the softkey area allow for switching between the main menu and the side menus and submenus.

The *NEXT* key calls the side menu.

The *PREVIOUS* key returns to the next higher menu.

Several menus provide for automatic change, i.e., return to the next higher menu is caused automatically after pressing a softkey.

Selection of a submenu is always effected via a softkey.



The labeling of all softkeys which call a submenu includes a ⇓ arrow.

Setting Parameters

Parameters are set either by simple selection (selection parameters) or by (alpha)numeric entries in data entry windows or tables.

The numeric keypad on the front panel, an external keyboard (optional), a roll-key and the cursor keys are provided for the entry of instrument parameters in an entry window or in a table.

The external keyboard is optional. If it is not fitted, the help line editor is called automatically for entry of alphanumeric parameters. The help line editor provides for selection of individual letters and a number of special characters which are copied into the actual entry window.

Numeric Keypad

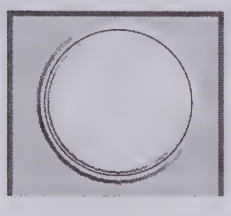
The numeric keypad is provided for entry of numeric parameters. It contains the following keys:

- Number keys 0 to 9
- Decimal point
  Inserts a decimal point "." at the cursor position.
- Sign key
  Changes the sign of the mantissa or exponent of a numeric parameter.
  A "-" is inserted at the cursor position in case of an alphanumeric parameter.
- Unit keys (*GHz/-dBm*, *MHz/dBm*, *kHz/dB* and *Hz/dB*)
  - Provide the numeric value entered with the selected unit and terminate the entry.
    The unit keys are all assigned the value "1" for dimensionless quantities or for level entries (e.g., in dB). The unit keys thus assume the function of an *ENTER* key.. The same applies for an alphanumeric entry.
  - Open and close the selection windows of tables.
- *BACK* key
  - Deletes the character left to the cursor with numeric entry.
  - Allows for toggling between the current and the previous values subsequent or prior to entry (UNDO function).
- *ESC/CANCEL* key
  - Aborts the entry before it has been terminated. The previous value is restored.
  - Closes the entry field after termination of input.
  - Closes system messages.
- *ENTER* key
  - Terminates the input of dimensionless quantities. The new value is set.

  Note: *The ENTER keys assumes the function of the Hz key for frequency input, and the function of the µs(kHz) key for time input.*

Roll-key and Cursor Keys

The roll-key and the cursor keys are arranged besides the numeric keypad.



The roll-key has various functions:

- With numeric entry, the instrument parameter is incremented (turning clockwise) or decremented (turning counterclockwise) at a defined step size.
- In tables, the roll-key can be used to shift the cursor horizontally or vertically when no entry window is open. The direction (horizontal/ vertical) is switched over using the cursor keys.
- The roll-key is used with the help-line editor to select the individual letters.
- It can be used to shift markers, display lines, limit lines etc.
- Pressing the roll-key terminates the input of parameters.

In tables, the cursor keys are used to shift the cursor between the lines and columns of the table.

The keys ⇦ and ⇨ are used to shift the cursor inside the entry window to reach a particular position in the string.

The keys ⇧ and ⇩

- increase or decrease the value of a parameter for numeric input .
- switch between editing line and help line editor for alphanumeric input.

Selection and Setting of Parameters via Keys or Softkeys

The selection of parameters and their settings is effected by means of a key, a softkey or in a table depending on the hierarchical level of the menu they are assigned to. Selection and setting of parameters in tables is described in section "Selection and Setting of Parameters in Tables" .

Selection via key

Most keys of the network analyzer are used to enter menus where the selection and the settings are made. Few settings can be made directly by means of a keystroke, only.

Example: Call up of preset settings

➢ Press *PRESET* key

The spectrum analyzer is brought into a predefined initial state.

Selection via softkey

In most cases the selection is made by pressing the respective softkey. There are various alternatives of making the selection:

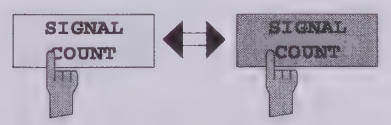
1. The softkey is active or inactive.

Example: Switching on/off the frequency counter

➢ Press *MKR* key.

➢ Press *SIGNAL COUNT* softkey.

Each time the softkey is pressed, the marker info list is switched on or off. If the softkey is active (= marker info list on), it is illuminated.



2. The softkey acts like a toggle switch, each pressing changes the active selection.

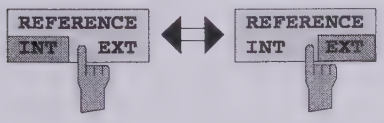
Example: Selection of the reference (internal or external)

➢ Press *SETUP* key.

➢ Press *GENERAL SETUP* softkey, the *GENERAL SETUP* submenu is opened.

➢ Press *REFERENCE INT/EXT* softkey.

With each pressing, the checkmark on the softkey changes from INT (internal reference) to EXT (external reference) and vice versa. When in the active setting the softkey menu item is illuminated.



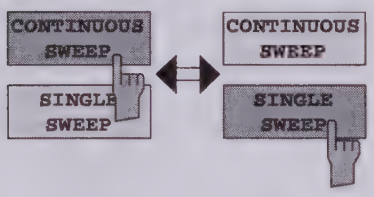
3. Various softkeys act like selection switches. Only one softkey may be active at a time.

Example: sweep setting

➢ Press *SWEEP* key.

➢ Press *CONTINOUS SWEEP* softkey.

The continuous sweep is thus set. The *CONTINOUS SWEEP* softkey is colored (factory-set: green). The second alternative, a series of n sweeps according to the trigger definition, can be selected via the *SINGLE SWEEP* softkey in the same menu. Only one of the two softkeys can be active at a time, the softkeys thus act like selection switches.



4. The softkey is used to select the parameter, the setting is made in an alphanumeric data entry window.

Example: SWEEP COUNT parameter

➢ Press *SWEEP* key

➢ Press *SWEEP COUNT* softkey.

The window for entering the number of sweeps for the SINGLE SWEEP mode is opened. The softkey is colored (factory-set: red). (Data entry is described in the next section).

4. The softkey is used to select the parameter, the setting is made in an (alpha)numeric data entry window. The softkey function is switched on. To switch off the function, the softkey has to be pressed again.

Example: parameter MARKER

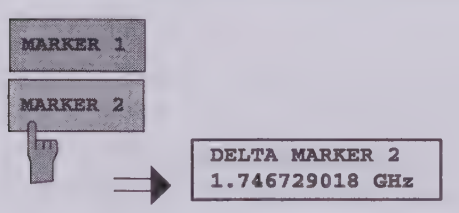
➢ Press *MRK* key.

➢ Press *MARKER 1* softkey.

The window for entering the marker frequency is opened. The softkey is colored (factory set: red).
Marker1 is switched on and the peak search is started.

➢ Press *MARKER 2* softkey.

The entry window for the marker frequency of marker 2 is opened. The softkey is colored (red), marker 2 is switched on, and the *MARKER 1* softkey turns green.



➢ Press *MARKER 1* softkey again.

Marker 1 is switched off.

5. The softkey selects the parameter, the setting is made in a selection table.

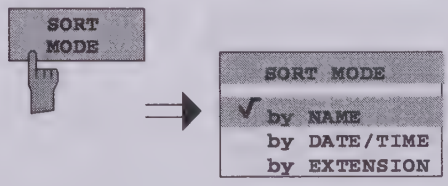
Example: Selection of the sorting criteria of a file list

➢ Press *FILE* key.

➢ Press *FILE MANAGER* softkey.

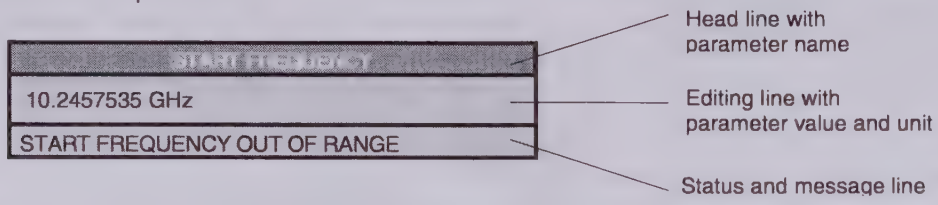
➢ Press *SORT MODE* softkey.

A selection table is displayed. The softkey is colored (factory-set: red). (operation see below).



Editing of Numeric Parameters

The entry of numeric values is always made in a data entry window, which is displayed automatically after selection of the parameter.


START FREQUENCY
10.2457535 GHz
START FREQUENCY OUT OF RANGE
Head line with parameter name
Editing line with parameter value and unit
Status and message line

The headline indicates the name of the instrument parameter, which has been selected. The entry is made in the editing line. Subsequent to calling the entry window, the current parameter value including the unit is displayed left-justified in the editing line. Status and error messages which refer to the current entry are displayed in the third and (optionally) fourth line.

Note: *Entry windows may be represented transparent (cf. DISPLAY - CONFIG DISPLAY menu)*

Entry of a numeric value

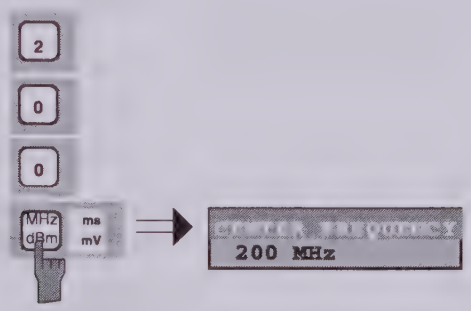
➢ Call data entry window (cf. selection of parameters)
The editing line indicates the current value

Example: center frequency (frequency-sweep mode)

Entry via number keys

➢ Enter required value via number keys.

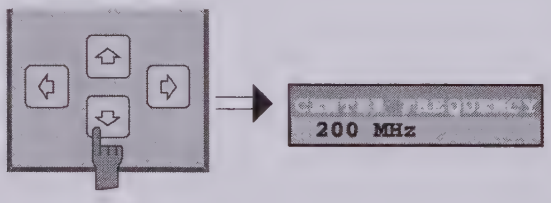
Example:



Entry via cursor keys

➢ Cursor ⇦ or ⇨ until obtaining the required value.

Example:



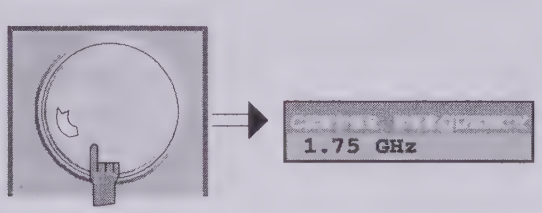
Entry via roll-key

➢ Rotate the roll-key until reaching the required value.

The variation step size increases with increasing rotational speed.

Turning the roll-key clockwise increases the value, turning it counterclockwise decreases the value.

Example:



Note: *When the value is modified by means of the roll-key or the cursor keys the new value is immediately set.*

Terminating the entry

➢ Press one of the unit keys

The unit is entered in the entry window and the new setting is accepted by the instrument.

For dimensionless quantities:

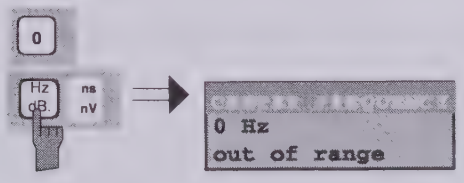
➢ Press the ENTER key or the roll-key

The new setting is accepted by the instrument.

A few data entry windows close automatically whereas others like the entry window for the start frequency remain open even after termination of the entry. They can be closed by pressing the *ESC* key.

If an error occurs, a corresponding error message is displayed in the status line of the entry window, e.g., "Out of range", "Value adjusted", etc. In this case, the new value is not accepted for the instrument setting.

Example:



Correcting the entry

Deleting an entry

➢ Position the cursor beside the digit which is to be deleted using the cursor keys ◁ or ▷.

➢ Press the *BACK* key. The entry left to the cursor is deleted.

➢ Enter new numbers. The number is inserted to the left of the cursor, the other numbers are shifted right.

Restoring the original value

➢ Press the *BACK* key

For numerous parameters, the data administration of the instrument stores the previously valid parameter value in addition to the current value. The BACK key can be used to toggle between these two values. This applies for terminated entries as long as the data entry window is displayed.

Aborting the entry

➢ Press *ESC* key

The original parameter value is restored. The new entry is deleted.

➢ Press *ESC* key again

The entry window is closed, the original value remains active.

or

➢ Press any key or any softkey (even the softkey which has opened the entry window).

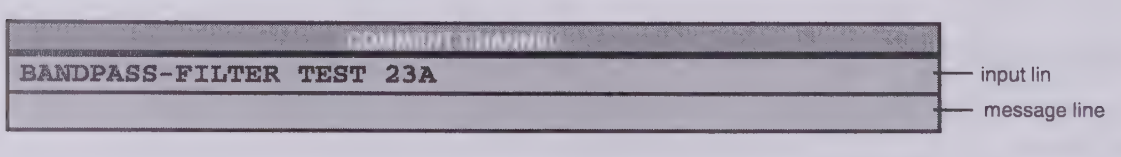
The entry is aborted and the entry window is closed. The original value remains active.

Entry of Alphanumeric Parameter

A help-line editor or an external keyboard (optional) are provided for the entry of alphanumeric instrument parameters.
The roll-key and the exponent key have no function with alphanumeric entry. All unit keys assume the function of an ENTER key.

The entry is always made in a data entry window which is displayed automatically upon selection of the parameter. The editing line comprises 60 characters. Up to 256 characters may be entered. If a text exceeds 60 characters the contents is shifted automatically 20 characters left or right when the left or right margin of the editing line is touched by the cursor.

Editing with External Keyboard



Entry of text

- ➢ Select parameter.
  The data entry is active automatically upon calling the data entry window. The cursor is positioned at the beginning of the previous entry.
- ➢ Press the required character on the keyboard.
  The character is inserted prior to the cursor.
- ➢ Enter further characters

Correcting the entry

- ➢ Delete the entry using the *DELETE* key or *BACKSPACE* key.

Terminating the entry

- ➢ Press the *ENTER* key of the external keyboard
  The data entry window is closed and the new value is accepted for the instrument.

Aborting the entry

- ➢ Press the **ESC** key on the front panel

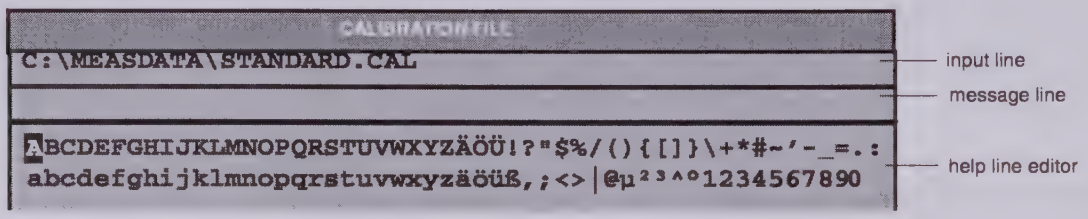
or

- ➢ any softkey.

  The data entry window is closed, the original value is retained.

Editing with Help Line Editor

If the external keyboard is not fitted, the help line editor is called automatically with entry of alphanumeric parameters. The help line editor is an extension of the alphanumeric entry window. It contains the complete alphabet with uppercase and lowercase letters as well as special characters in two lines of 52 characters, each. Individual letters and a series of special characters can be selected in the help line editor and copied into the entry line.



The cursor keys ⇧ or ⇩ toggle between entry in the editing line and selection in the help line editor.

Entry of text

- ➢ Select parameter.
  The data entry is active automatically upon calling the data entry window. The cursor is positioned on the left in the editing line.
- ➢ Position the cursor in the help line editor using the cursor key. ⇩
  The cursor marks the first letter of the editor.
- ➢ Locate the cursor on the character which is to be entered into the editing line using the cursor keys ⇦ or ⇨ or the roll-key.
- ➢ Press the *ENTER* key or the roll-key
  The character is entered in the editing line.

Correcting the entry

- ➢ Locate the cursor in the editing line using the cursor key ⇧ .
- ➢ Position the cursor after the character which is to be deleted using the cursor keys ⇦ and ⇨ .
- ➢ Press the *BACK* key.
  The entry left to the cursor is deleted.

Terminating the entry

- ➢ Locate the cursor in the editing line using the cursor key ⇧ .
- ➢ Press any unit key or the roll-key.
  The data entry window is closed, the new entry is accepted by the instrument.

Aborting the entry

- ➢ Press the *CLR* key.
  The data entry window is closed, the previous entry is retained.

Selection and Setting of Parameters via Tables

The spectrum analyzer uses numerous tables for display and configuration of instrument parameters.

The tables differ considerably in the number of lines, columns and inscriptions. The basic steps of operation for the selection and setting of parameters are, however, the same for all tables. Shown below is the typical entry of parameters into a table.

Note:

Most of the tables are coupled to a softkey menu which provides further functions for editing table entries such as deletion of tables, copying of lines or columns, marking of table elements, restoring default states.

The definition of individual tables and the operation of particular editing functions can be looked up in the description of the corresponding softkey menu.

1. Activating the table

- If the menu has only one table, the latter is activated automatically subsequent to calling this menu in most cases and the marking cursor is positioned to the top field of the left column.
- If the menu contains various tables, the table of interest must be selected using the softkey which is labeled with the title of the table.

2. Selection of the parameter

marking cursor

NAME	COMPATIBLE	LIMIT CHECK	TRACE	MARGIN
GSM22UP	√	off	1	0 dB
√ LP1GHz		on	2	0 dB
√ LP1GHz	√	off	1	0 dB
MIL461A		off	2	

Selection of the parameter (or the setting) is made using the marking cursor.

➢ Press the cursor keys to move to the wanted field.

or

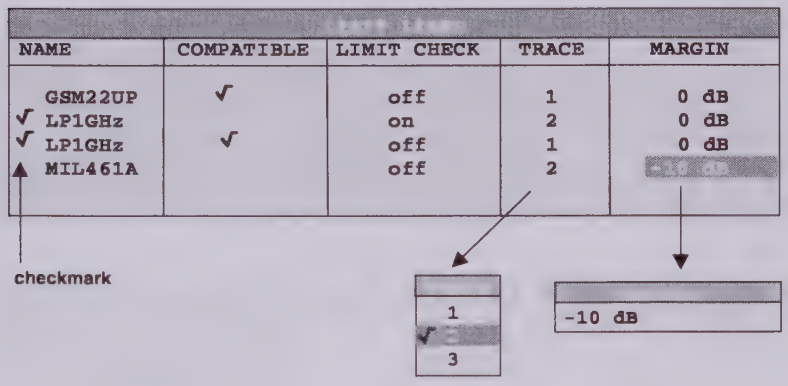
➢ Rotate the roll-key until the wanted field is marked. The cursor keys are used to specify the direction of the roll-key movement (horizontal or vertical)

When shifting the cursor, elements may be skipped which can not be edited. Table elements, which can not be selected are indicated by a different color.

➢ Press the *ENTER* key or the roll-key.
The parameter/the setting has been selected.

The selected parameter can be edited the way described below:

3. Editing the marked parameter



a) Toggling between two states

If an element of a table can be switched on and off only, the unit keys are used to toggle between these two states.

➢ Press one of the unit keys.
The table element is switched on and provided with a checkmark. (√).

➢ Press one of the unit keys once more.
The table element is switched off.

or

➢ Press one of the unit keys.
The table element is switched on, "on" is displayed.

➢ Press one of the unit keys once more.
The table element is switched off, "off" is displayed

b) Opening a data entry window

If a table entry consists of an (alpha-) numeric value, selection of the latter causes the corresponding entry window to be opened.

Note: *For numeric or alphanumeric instrument parameters, the editing operation may be started by entering any number or letter on the front panel or on the external keyboard. In this case, the data entry window is opened automatically.*

c) Opening a selection table

If a table entry may have various states (e.g., colors from a color pallet, fixed filter bandwidths, etc.), a table indicating all possible states is displayed with selection. The current state is and marked by a checkmark and by the cursor.

- ➢ Set the cursor to the desired setting.
- ➢ Press one of the unit keys.
  The setting is switched on and marked (√). The selection table closes and the value is transferred to the original table. The cursor is positioned automatically on the next table element.

Abortion of entry

➢ Press the *ESC* key.

The current entry/selection is aborted and the original setting is restored.

Scrolling

Some tables contain more entries than can be displayed on one screen page. In this case, a **scrollbar** is displayed at the right margin of the table, whose slider shows the current position in the text.

➢ Actuate the *PAGE UP* or *PAGE DOWN* softkeys.

The table is paged forward or back by one page.

➢ Press cursor key ⊡ or ⊡.

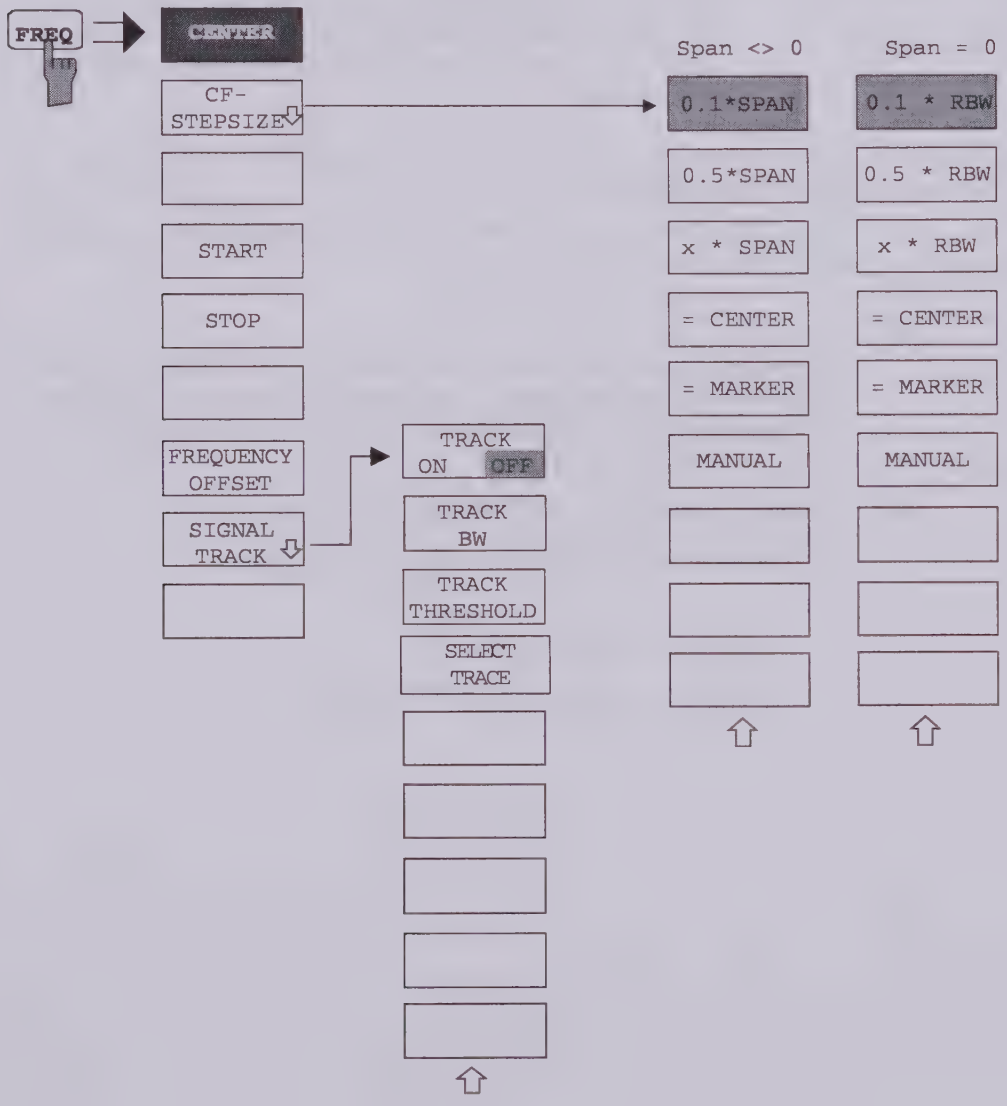
The table is scrolled up or down by one line.

Menu Overview

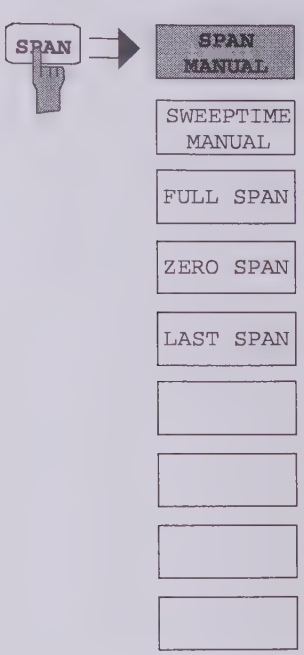
The following section gives a graphical overview of the FSP menus. Side menus are marked by an arrow directed to the left/right, submenus by an arrow showing upwards.
The menus appear in the order corresponding to the arrangement of keys on the front panel. The available hotkeys and the LOCAL menu appearing during the remote control of the instrument are also displayed.

The functions of menus are described in detail in Chapter 4. The IEC/IEEE-bus command associated with each softkey is indicated. In addition, the softkey list at the of Chapter 6 gives the assignment of IEC/IEEE-bus commands to softkeys.

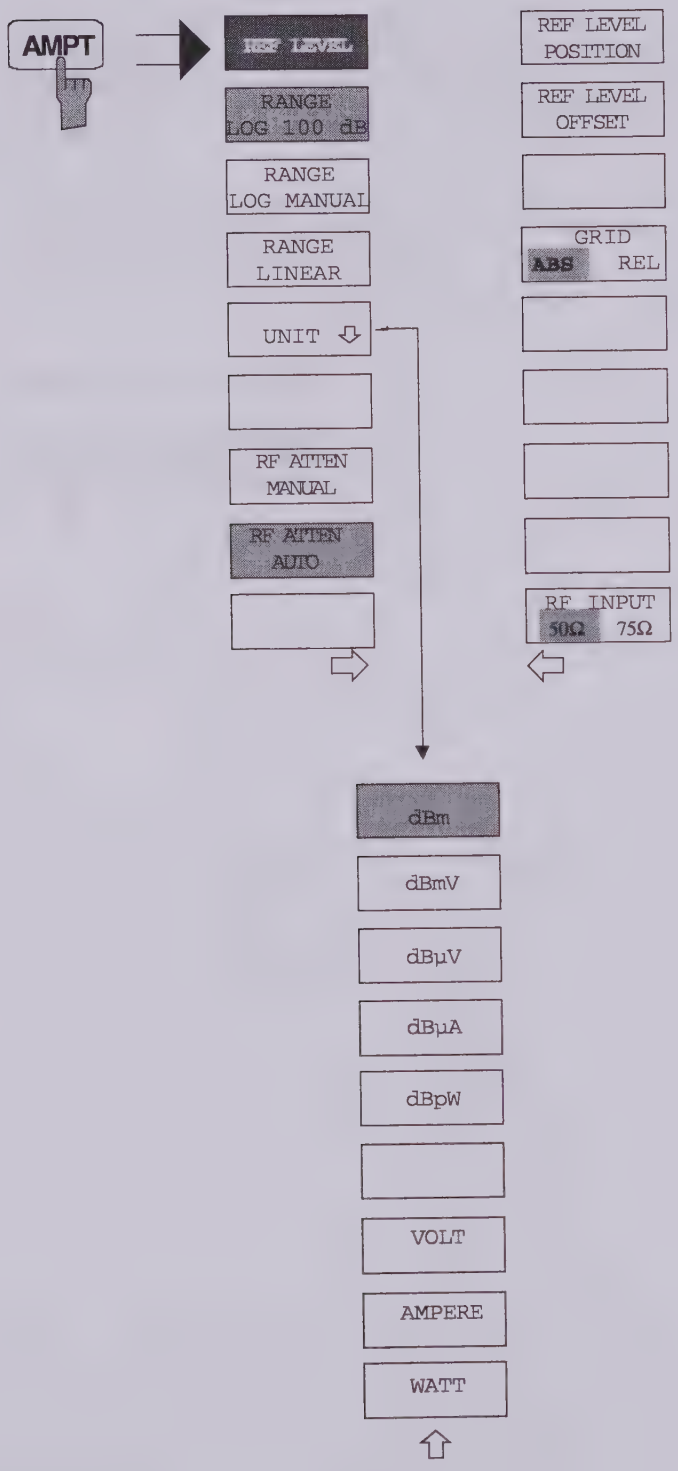
FREQUENCY Key



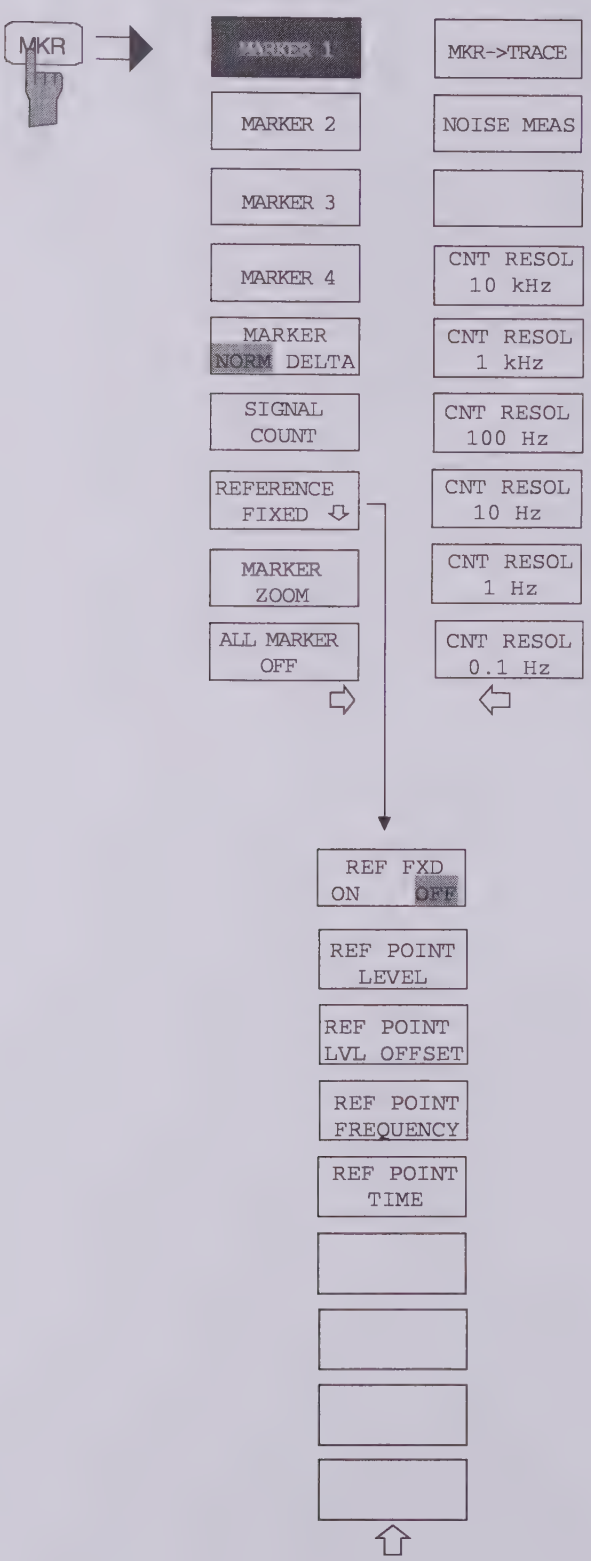
SPAN Key


SPAN
SPAN MANUAL
SWEEPTIME MANUAL
FULL SPAN
ZERO SPAN
LAST SPAN

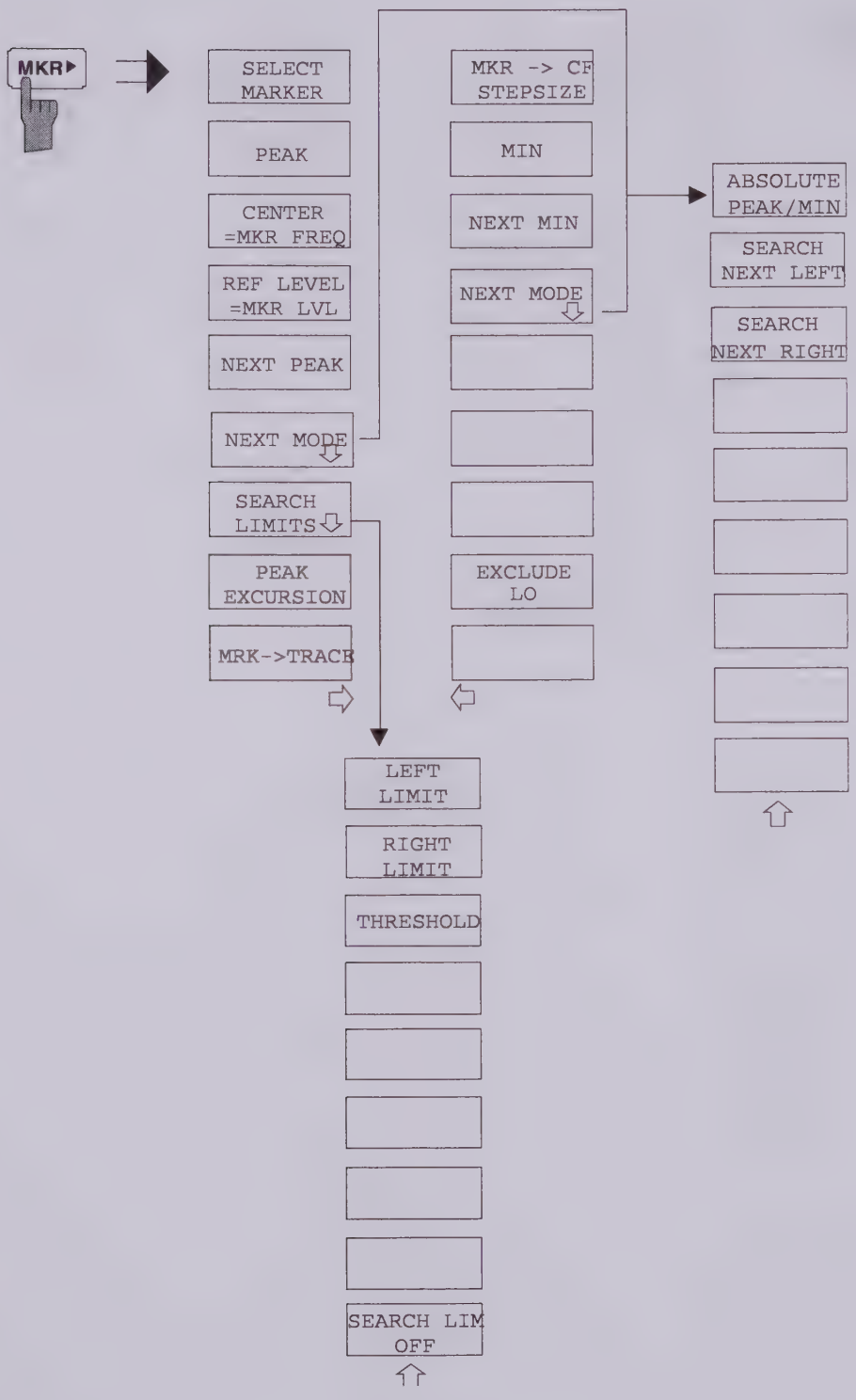
AMPT Key


AMPT
REF LEVEL
RANGE LOG 100 dB
RANGE LOG MANUAL
RANGE LINEAR
UNIT
RF ATTEN MANUAL
RF ATTEN AUTO
REF LEVEL POSITION
REF LEVEL OFFSET
GRID ABS REL
RF INPUT 50Ω 75Ω
dBm
dBmV
dBµV
dBµA
dBpW
VOLT
AMPERE
WATT

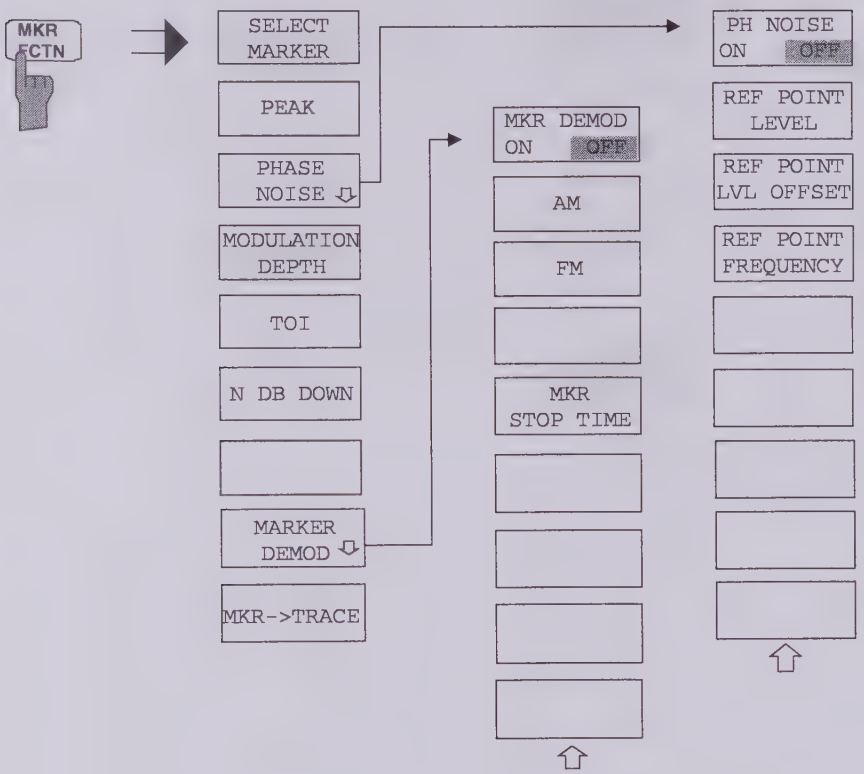
MKR Key


MKR
MARKER 1
MARKER 2
MARKER 3
MARKER 4
MARKER
NORM DELTA
SIGNAL
COUNT
REFERENCE
FIXED
MARKER
ZOOM
ALL MARKER
OFF
MKR->TRACE
NOISE MEAS
CNT RESOL
10 kHz
CNT RESOL
1 kHz
CNT RESOL
100 Hz
CNT RESOL
10 Hz
CNT RESOL
1 Hz
CNT RESOL
0.1 Hz
REF FXD
ON OFF
REF POINT
LEVEL
REF POINT
LVL OFFSET
REF POINT
FREQUENCY
REF POINT
TIME

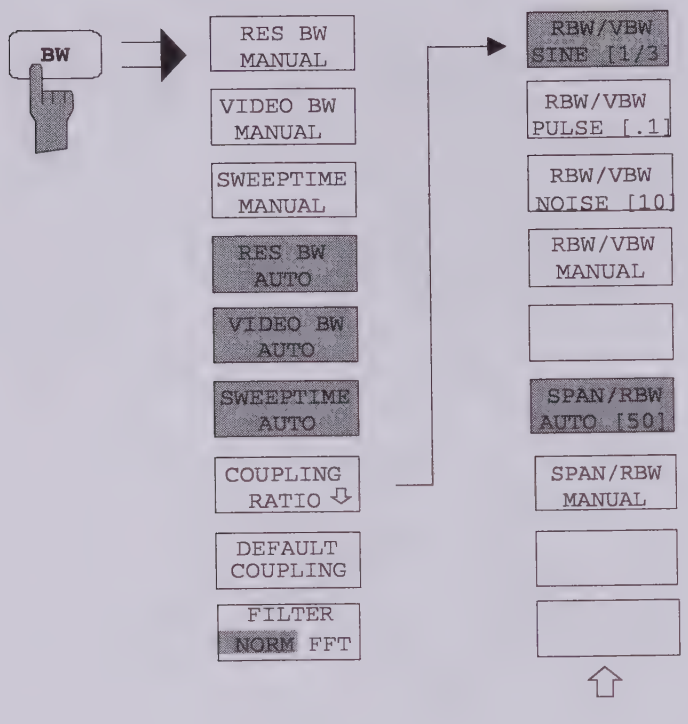
MKR-> Key


MKR
SELECT MARKER
PEAK
CENTER =MKR FREQ
REF LEVEL =MKR LVL
NEXT PEAK
NEXT MODE
SEARCH LIMITS
PEAK EXCURSION
MRK->TRACE
MKR -> CF STEPSIZE
MIN
NEXT MIN
NEXT MODE
EXCLUDE LO
ABSOLUTE PEAK/MIN
SEARCH NEXT LEFT
SEARCH NEXT RIGHT
LEFT LIMIT
RIGHT LIMIT
THRESHOLD
SEARCH LIM OFF

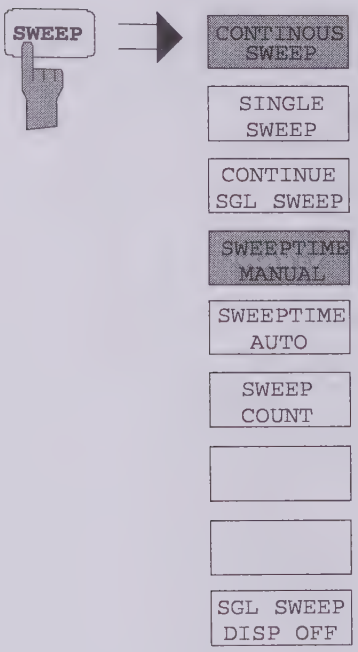
MKR FCTN Key


MKR FCTN
SELECT MARKER
PEAK
PHASE NOISE
MODULATION DEPTH
TOI
N DB DOWN
MARKER DEMOD
MKR->TRACE
MKR DEMOD ON OFF
AM
FM
MKR STOP TIME
PH NOISE ON OFF
REF POINT LEVEL
REF POINT LVL OFFSET
REF POINT FREQUENCY

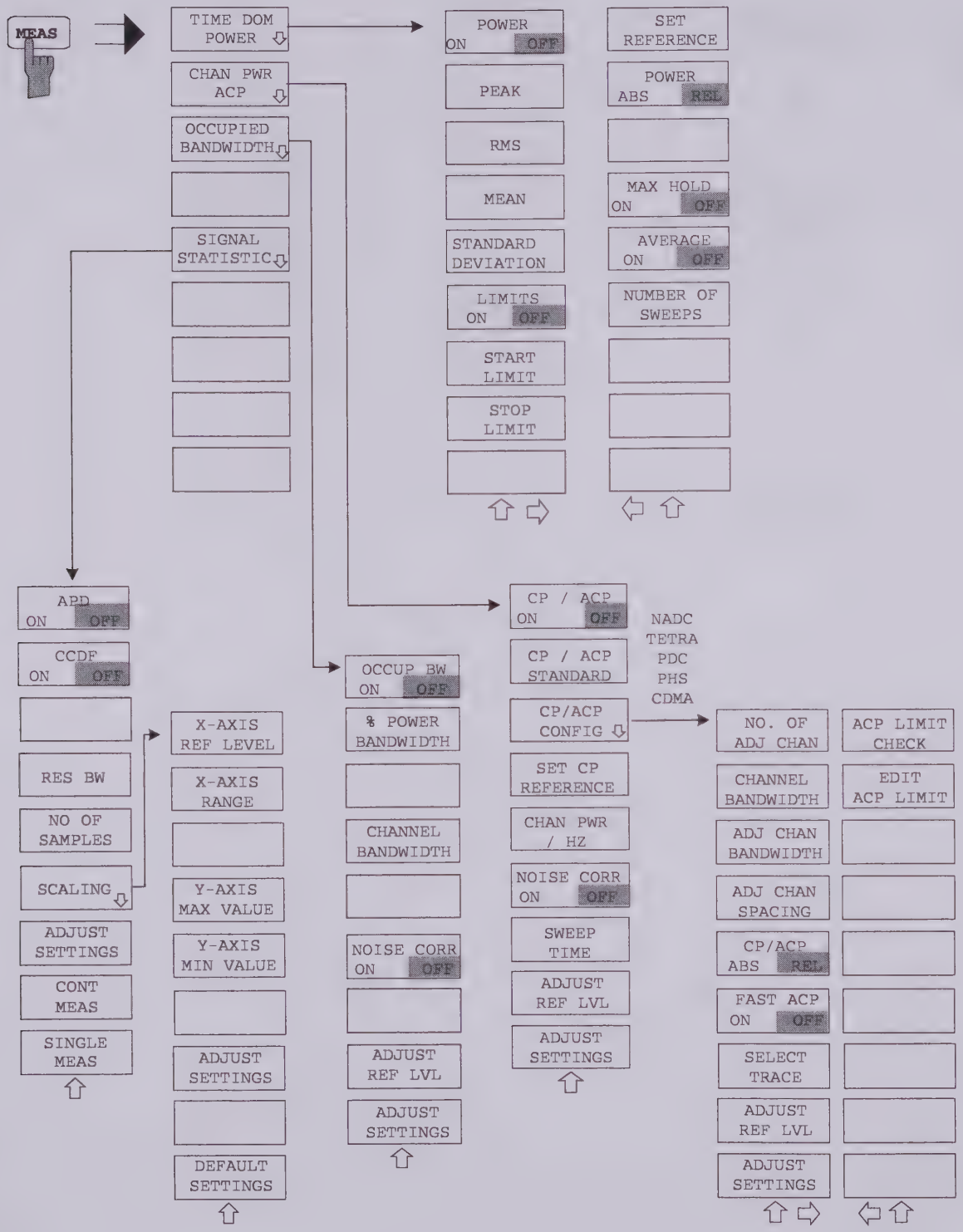
BW Key


BW
RES BW MANUAL
VIDEO BW MANUAL
SWEEPTIME MANUAL
RES BW AUTO
VIDEO BW AUTO
SWEEPTIME AUTO
COUPLING RATIO
DEFAULT COUPLING
FILTER NORM FFT
RBW/VBW SINE [1/3]
RBW/VBW PULSE [.1]
RBW/VBW NOISE [10]
RBW/VBW MANUAL
SPAN/RBW AUTO [50]
SPAN/RBW MANUAL

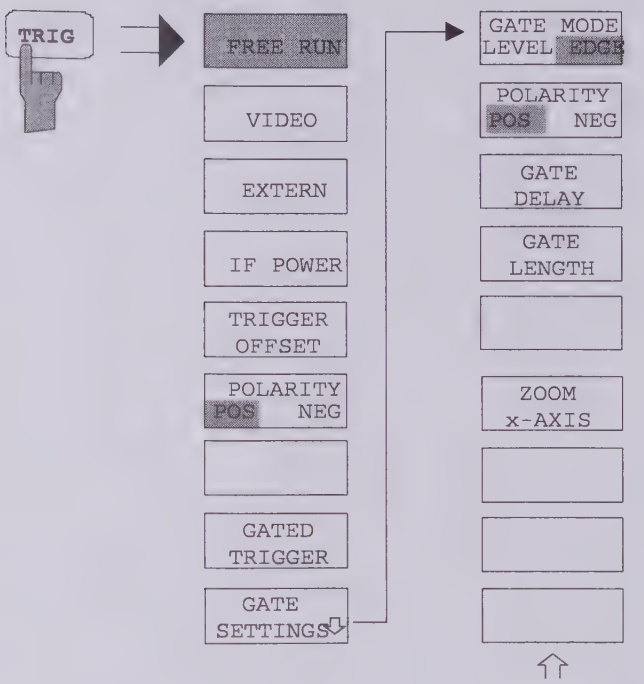
SWEEP Key


SWEEP
CONTINOUS SWEEP
SINGLE SWEEP
CONTINUE SGL SWEEP
SWEEPTIME MANUAL
SWEEPTIME AUTO
SWEEP COUNT
SGL SWEEP DISP OFF

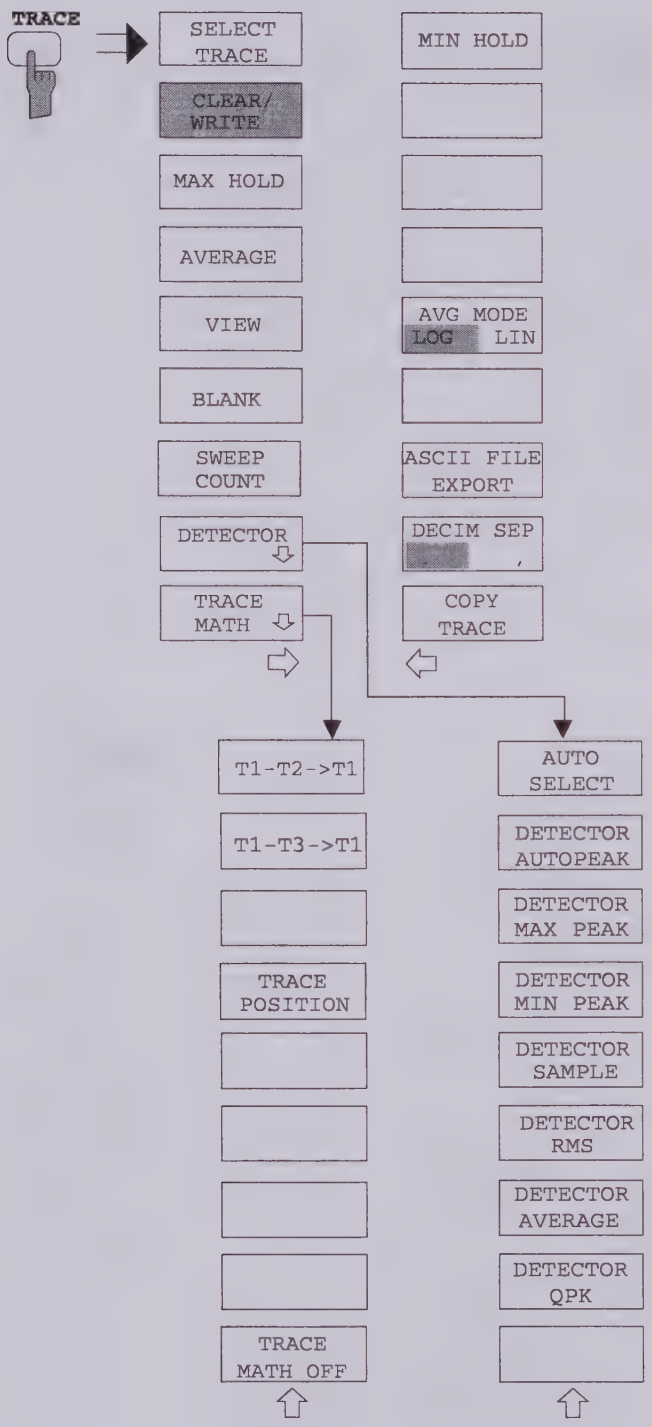
MEAS Key


MEAS
TIME DOM POWER
CHAN PWR ACP
OCCUPIED BANDWIDTH
SIGNAL STATISTIC
POWER ON OFF
PEAK
RMS
MEAN
STANDARD DEVIATION
LIMITS ON OFF
START LIMIT
STOP LIMIT
SET REFERENCE
POWER ABS REL
MAX HOLD ON OFF
AVERAGE ON OFF
NUMBER OF SWEEPS
APD ON OFF
CCDF ON OFF
RES BW
NO OF SAMPLES
SCALING
ADJUST SETTINGS
CONT MEAS
SINGLE MEAS
X-AXIS REF LEVEL
X-AXIS RANGE
Y-AXIS MAX VALUE
Y-AXIS MIN VALUE
ADJUST SETTINGS
DEFAULT SETTINGS
OCCUP BW ON OFF
% POWER BANDWIDTH
CHANNEL BANDWIDTH
NOISE CORR ON OFF
ADJUST REF LVL
ADJUST SETTINGS
CP / ACP ON OFF
CP / ACP STANDARD
CP/ACP CONFIG
SET CP REFERENCE
CHAN PWR / HZ
NOISE CORR ON OFF
SWEEP TIME
ADJUST REF LVL
ADJUST SETTINGS
NADC
TETRA
PDC
PHS
CDMA
NO. OF ADJ CHAN
CHANNEL BANDWIDTH
ADJ CHAN BANDWIDTH
ADJ CHAN SPACING
CP/ACP ABS REL
FAST ACP ON OFF
SELECT TRACE
ADJUST REF LVL
ADJUST SETTINGS
ACP LIMIT CHECK
EDIT ACP LIMIT

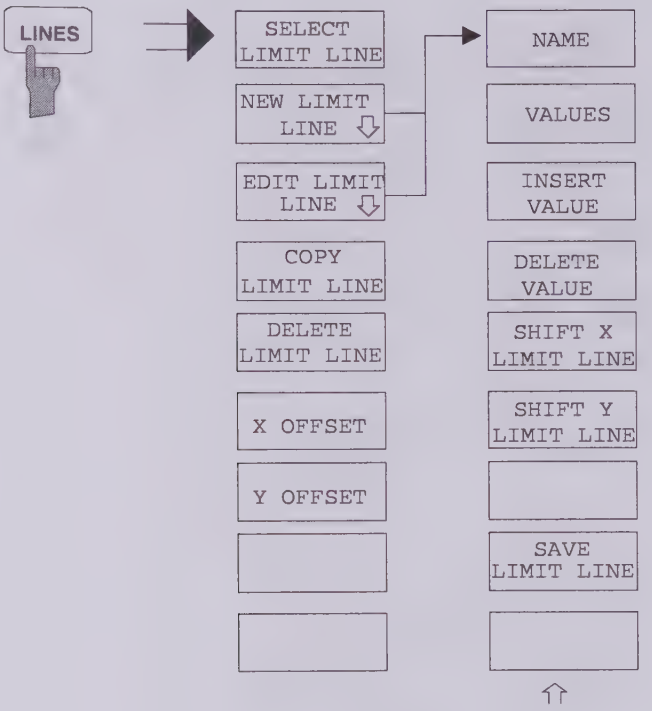
TRIG Key


TRIG
FREE RUN
VIDEO
EXTERN
IF POWER
TRIGGER OFFSET
POLARITY POS NEG
GATED TRIGGER
GATE SETTINGS
GATE MODE LEVEL EDGE
POLARITY POS NEG
GATE DELAY
GATE LENGTH
ZOOM x-AXIS

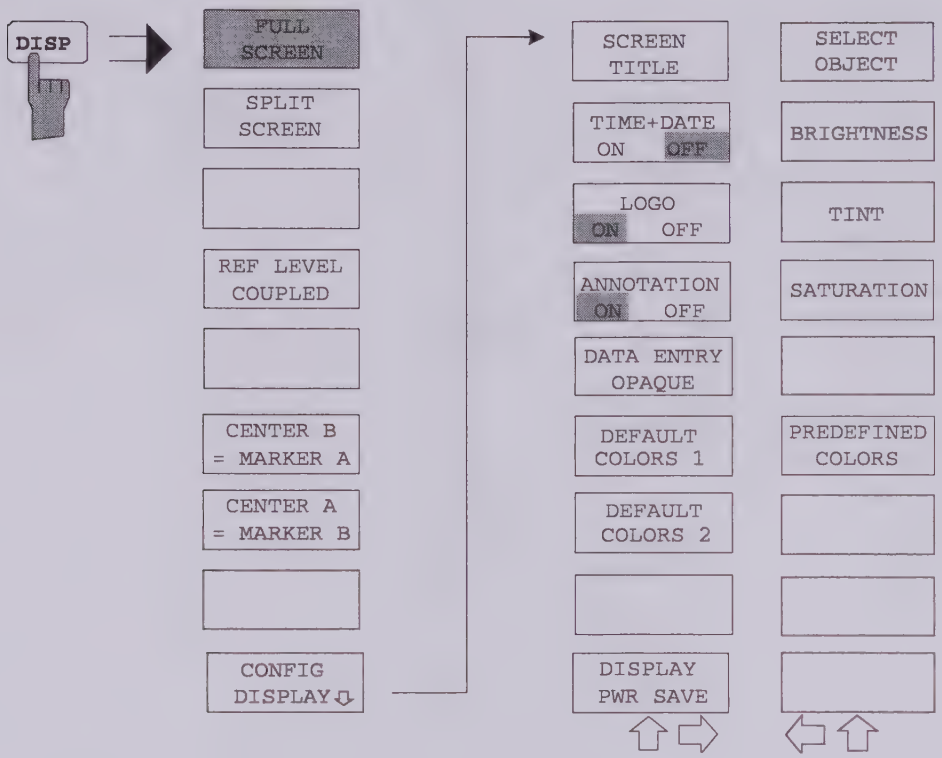
TRACE Key


TRACE
SELECT TRACE
CLEAR/ WRITE
MAX HOLD
AVERAGE
VIEW
BLANK
SWEEP COUNT
DETECTOR
TRACE MATH
MIN HOLD
AVG MODE LOG LIN
ASCII FILE EXPORT
DECIM SEP ,
COPY TRACE
T1-T2->T1
T1-T3->T1
TRACE POSITION
TRACE MATH OFF
AUTO SELECT
DETECTOR AUTOPEAK
DETECTOR MAX PEAK
DETECTOR MIN PEAK
DETECTOR SAMPLE
DETECTOR RMS
DETECTOR AVERAGE
DETECTOR QPK

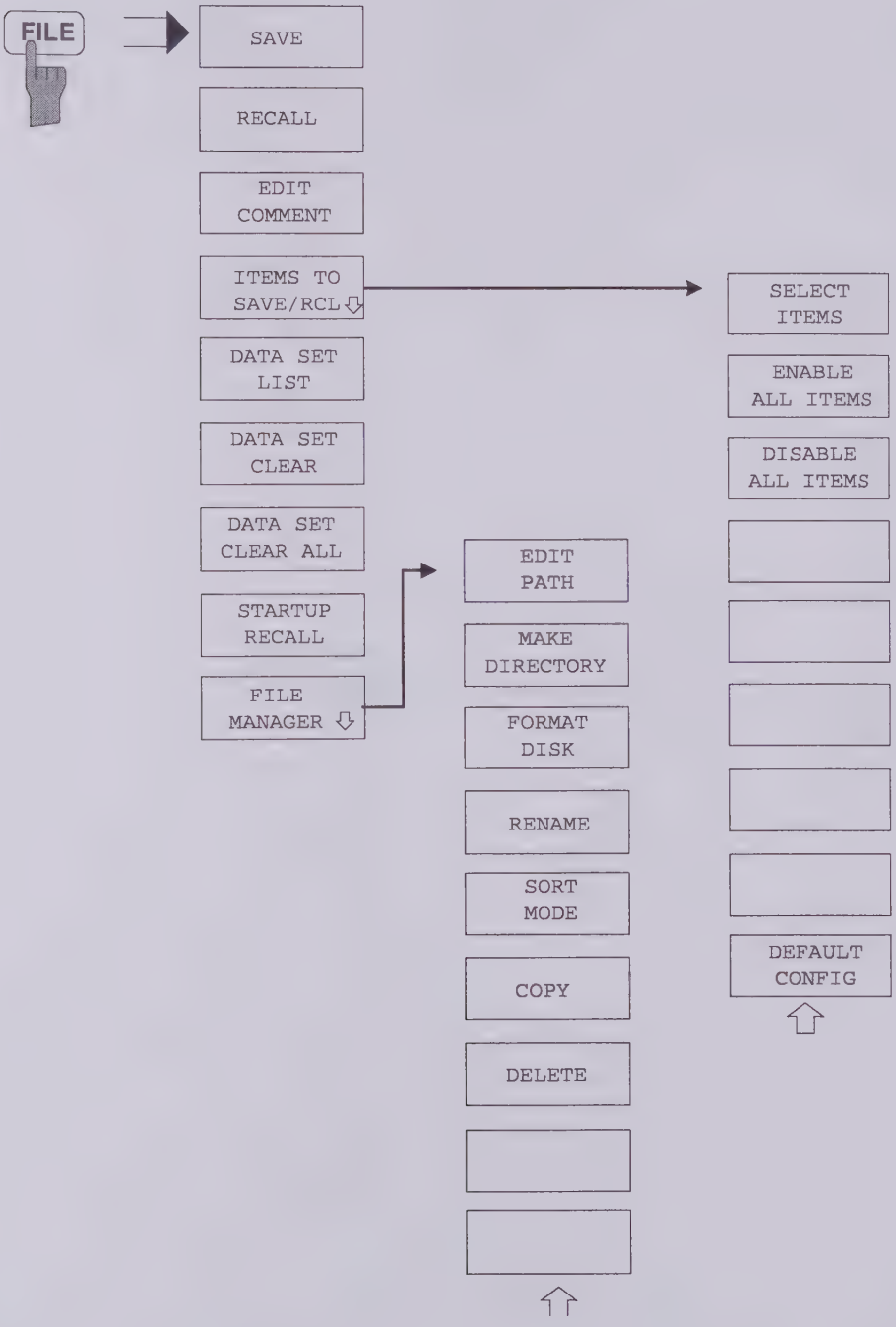
LINES Key


LINES
SELECT LIMIT LINE
NEW LIMIT LINE
EDIT LIMIT LINE
COPY LIMIT LINE
DELETE LIMIT LINE
X OFFSET
Y OFFSET
NAME
VALUES
INSERT VALUE
DELETE VALUE
SHIFT X LIMIT LINE
SHIFT Y LIMIT LINE
SAVE LIMIT LINE

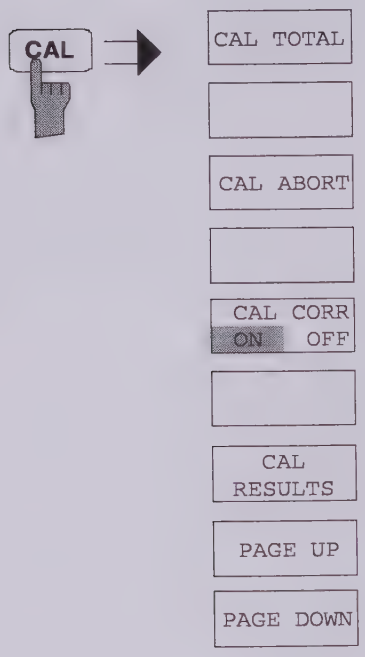
DISP Key


DISP
FULL SCREEN
SPLIT SCREEN
REF LEVEL COUPLED
CENTER B = MARKER A
CENTER A = MARKER B
CONFIG DISPLAY
SCREEN TITLE
TIME+DATE ON OFF
LOGO ON OFF
ANNOTATION ON OFF
DATA ENTRY OPAQUE
DEFAULT COLORS 1
DEFAULT COLORS 2
DISPLAY PWR SAVE
SELECT OBJECT
BRIGHTNESS
TINT
SATURATION
PREDEFINED COLORS

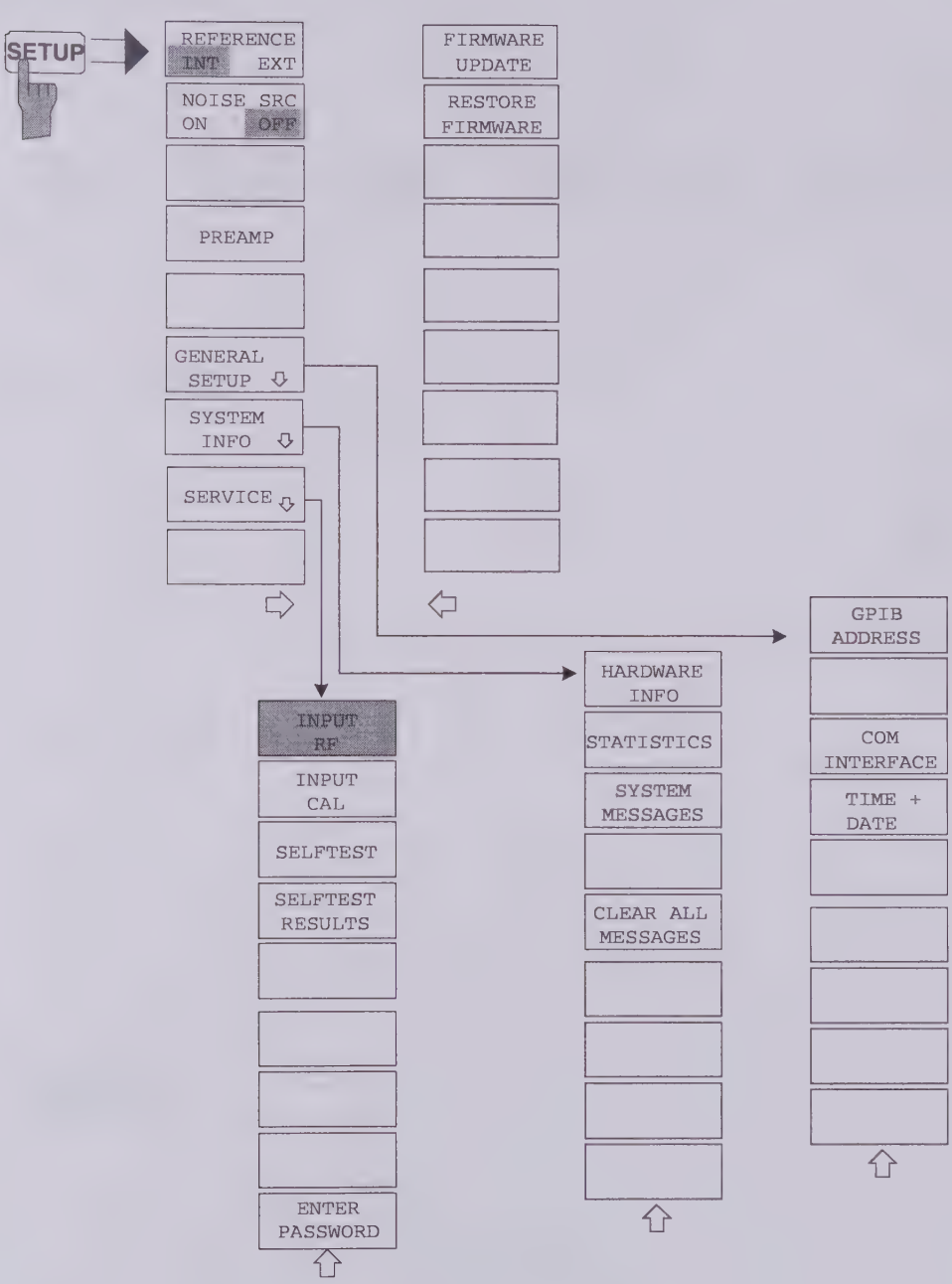
FILE Key


FILE
SAVE
RECALL
EDIT COMMENT
ITEMS TO SAVE/RCL
DATA SET LIST
DATA SET CLEAR
DATA SET CLEAR ALL
STARTUP RECALL
FILE MANAGER
SELECT ITEMS
ENABLE ALL ITEMS
DISABLE ALL ITEMS
DEFAULT CONFIG
EDIT PATH
MAKE DIRECTORY
FORMAT DISK
RENAME
SORT MODE
COPY
DELETE

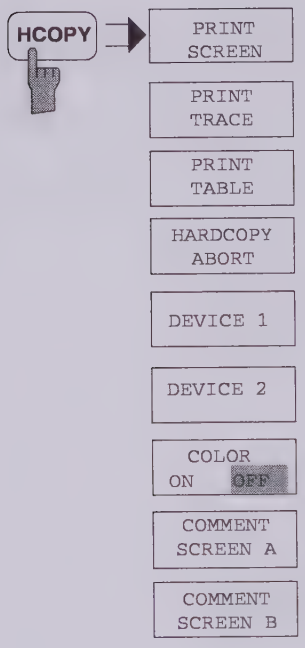
CAL Key


CAL
CAL TOTAL
CAL ABORT
CAL CORR
ON OFF
CAL
RESULTS
PAGE UP
PAGE DOWN

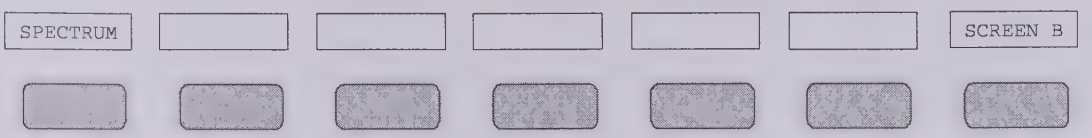
SETUP Key


SETUP
REFERENCE
INT EXT
NOISE SRC
ON OFF
PREAMP
GENERAL
SETUP
SYSTEM
INFO
SERVICE
FIRMWARE
UPDATE
RESTORE
FIRMWARE
GPIB
ADDRESS
COM
INTERFACE
TIME +
DATE
HARDWARE
INFO
STATISTICS
SYSTEM
MESSAGES
CLEAR ALL
MESSAGES
INPUT
RF
INPUT
CAL
SELFTEST
SELFTEST
RESULTS
ENTER
PASSWORD

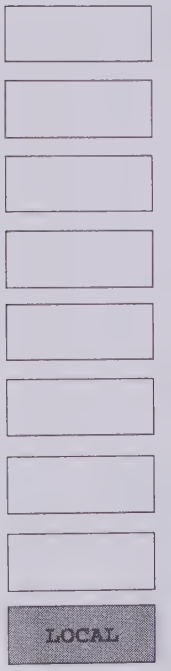
HCOPY Key


HCOPY
PRINT SCREEN
PRINT TRACE
PRINT TABLE
HARDCOPY ABORT
DEVICE 1
DEVICE 2
COLOR
ON OFF
COMMENT SCREEN A
COMMENT SCREEN B

Hotkey Menu



LOCAL Menu



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4 Instrument Functions

All functions of the spectrum analyzer and their application are explained in detail in this chapter. The sequence of the described menu groups depends on the procedure selected for the configuration and start of a measurement:

1. Resetting the instrument - *PRESET* key
2. Setting the mode – hotkey bar and *LOCAL* key
3. Setting the measurement parameters - keys *FREQ*, *SPAN*, *AMPT*, *BW*, *SWEEP*, *TRIG*, *TRACE*, *CAL*
4. Selecting and configuring the measurement function - keys *MKR*, *MKR->*, *MKR FCTN*, *MEAS*, *LINES*

The instrument functions for general settings, printout and data management are described at the end of this chapter – keys *DISP*, *SETUP*, *FILE* and *HCOPY*.

The different softkeys of a menu are described from top to bottom and from the left to the right side menu. The submenus are marked by an indentation or displayed in a separate section. The whole path (key - softkey - ...) is indicated in the line above the menu display.

An overview of the menus is given in chapter 3 which also contains the description of the operating concept.

The IEC/IEEE-bus commands (if any) are indicated for each softkey. For fast lookup a list of softkeys with the associated IEC/IEEE-bus commands is given at the end of Chapter 6.

An index at the end of the handbook serves as further help for the user.

FSP Initial Configuration – *PRESET* Key

Using the *PRESET* key, the FSP can be brought to a predefined initial state.

Notes: *The setting is selected so that the RF input is in any way protected against provided the applied signal levels are in the range admissible for the instrument.*

The initial state set by the PRESET key can be adapted to arbitrary applications using the STARTUP RECALL function. This function implies that the STARTUP RECALL dataset is loaded upon pressing the PRESET key. For further information refer to section "Saving and Recalling Data Sets".

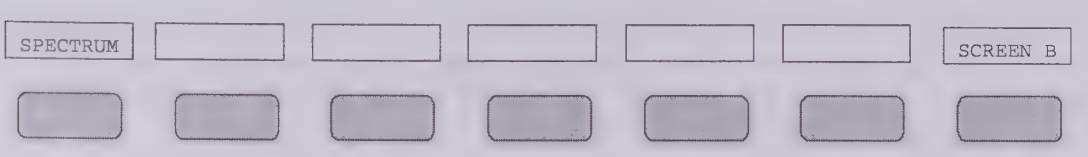
Pressing the *PRESET* key, causes the FSP to enter its initial state according to the following table:

Table 4-1 Initial State of FSP

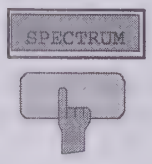
Parameter	Settings
Mode	Spectrum
Centerfrequency	1,5 GHz / 3,5 GHz (FSP3/7)
Center frequency step size	0.1 * Center Frequency
Span	3 GHz / 7 GHz (FSP3/7)
RF attenuation	auto (10 dB)
Reference lLevel	-20 dBm
Level range	100 dB log
Level unit	dBm
Sweep time	auto
Resolution bandwidth	auto (10 MHz)
Video bandwidth	auto (3 MHz)
FFT filter	off
Span / RBW	50
RBW / VBW	0.33
Sweep	cont
Trigger	free run
Trace 1	clr write
Trace 2/3	blank
Detector	auto peak
Trace mathematics	off
Frequency Offset	0 Hz
Reference level offset	0 dB
Reference level position	100 %
Grid	abs
Cal correction	on
Noise source	off
Input	RF
Display	Full screen, active screen A

Mode Selection – *HOTKEY* Bar

For fast mode selection FSP has seven keys (the so-called *HOTKEY*s) which can be allocated depending on the options installed on the instrument.



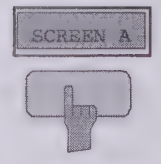
Two keys are reserved for the basic model:



The *SPECTRUM* hotkey sets FSP to spectrum analysis mode.

The spectrum analysis mode is the basic setting of FSP.

IEC/IEEE-bus command: `INST:SEL SAN`



With the *SCREEN A / SCREEN B* hotkey two different settings can be selected on the FSP in the FULL SCREEN mode.

In the SPLIT SCREEN mode the key switches between active diagram A and B.

The key designation indicates the diagram which has been activated by means of the key.

The currently active window is marked by **A** or **B** on the right of the diagram.

IEC/IEEE-bus command: `DISP:WIND<1|2>:SEL`

The meaning of the other keys is described in the operating manuals of the various options.

Switchover to Manual Control – *LOCAL* Menu

The menu LOCAL is displayed on switching the instrument to remote control mode.

At the same time, the *HOTKEY* bar is blanked out and all keys are disabled except the *PRESET* key. The diagram, traces and display fields are then blanked out (they can be activated using the remote control command `SYSTem:DISPlay:UPDate ON`).

The menu contains only one softkey, the *LOCAL*. The *LOCAL* key switches the instrument from remote to manual control, with the assumption that the remote controller has not previously set the LOCAL LOCKOUT function.

A change in the control mode consists of:

- **Enabling the Front Panel Keys**
  Returning to manual mode enables all inactive keys and turns on the hotkey menu. The soft key menu which is displayed is the main menu of the current mode.

  Inserting the measurement diagrams
  The blanked diagrams, traces and display fields are inserted.

- **Generating the message OPERATION COMPLETE**
  If, at the time of pressing the *LOCAL* softkey, the synchronisation mechanism via *OPC, *OPC? or *WAI is active, the currently running measurement procedure is aborted and synchronisation is achieved by setting the corresponding bits in the registers of the status reporting system.

- **Setting Bit 6 (User Request) of the Event Status Register**
  With a corresponding configuration of the status reporting system, this bit immediately causes the generation of a service request (*SRQ*) which is used to inform the software that the user wishes to return to front-panel control. This information can be used, e.g., to interrupt the control program so that the user can make necessary manual corrections to instrument settings. This bit is set each time the *LOCAL* softkey is pressed.

Note: *If the LOCAL LOCKOUT function is active in the remote control mode, the front-panel PRESET key is also disabled. The LOCAL LOCKOUT state is left as soon as the process controller de-activates the REN line or the IEC/IEEE-bus cable is unplugged from the instrument.*

Spectrum Analyzer Mode

The analyzer mode is activated by pressing hotkey *SPECTRUM* menu (see also Section 'Mode Selection')

The *SPECTRUM* hotkey selects the *ANALYZER* mode.

This mode is the default setting of the FSP.

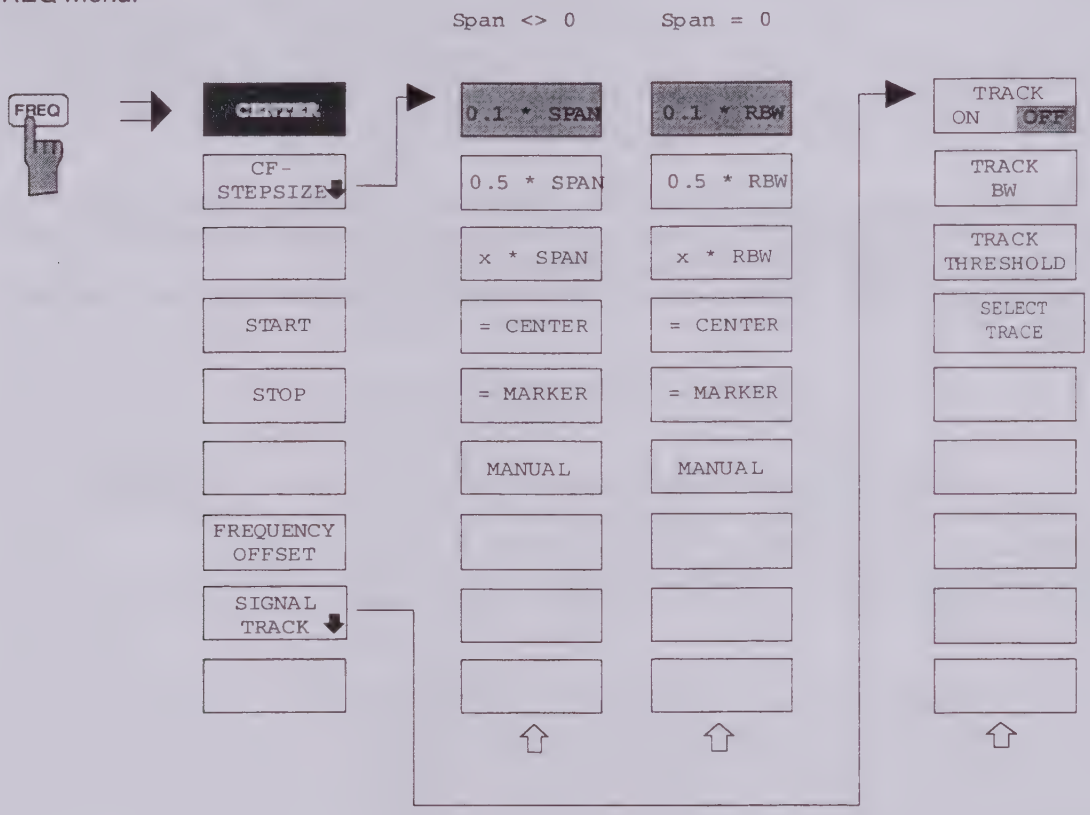
The functions provided correspond to those of a conventional spectrum analyzer. The analyzer measures the frequency spectrum of the test signal over the selected frequency range with the selected resolution and sweep time, or, for a fixed frequency, displays the waveform of the video signal.

Note: *If two displays (screen A and screen B) are opened after switch-on of signal analysis, the analyzer mode is only set for the display activated for entry (marked at the top right corner of diagram). For the other display, the previous settings remain valid.*
Storage and display of measured values is sequential: first in the upper and then in the lower display.

Frequency and Span Selection – *FREQ* Key

The *FREQ* key is used to specify the frequency axis of the active display window. The frequency axis can be defined either by the start and stop frequency or by the center frequency and the span (*SPAN* key). With two windows (*SPLIT SCREEN)* displayed at the same time, the input data always refer to the window selected in the *SYSTEM-DISPLAY* menu.
After pressing one of the *CENTER*, *START* or *STOP* softkeys, the value of the corresponding parameter can be defined in an input window.

FREQ menu:



The *CENTER* softkey opens the window for manually entering the center frequency.

The permissible range of values for the center frequency is:

for the frequency domain (span >0):

minspan/2 $\leq f_{center} \leq f_{max}$ – minspan/2

and for the time domain (span = 0): 0 Hz $\leq f_{center} \leq f_{max}$

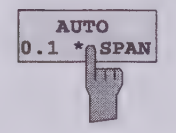
f_{center}	center frequency
minspan	smallest selectable span > 0 Hz (10 Hz)
f_{max}	max. frequency

IEC/IEEE-bus command: `FREQ:CENT 100MHz`

The CF *STEPSIZE* softkey opens a submenu for setting the step size of the center frequency. The step size can be coupled to the span (frequency domain) or the resolution bandwidth (time domain) or it can be manually set to a fixed value. The softkeys are mutually exclusive selection keys.

The softkeys are presented according to the selected domain (frequency or time).

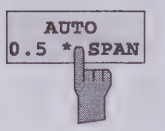
Softkeys in frequency domain:



The *0.1 * SPAN* softkey sets the step size for the center frequency entry to 10% of the span.

IEC/IEEE-bus command:

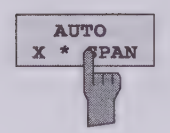
```
FREQ:CENT:STEP:LINK SPAN
FREQ:CENT:STEP:LINK:FACT 10PCT
```



The *0.5 * SPAN* softkey sets the step size for the center frequency entry to 50% of the span.

IEC/IEEE-bus command:

```
FREQ:CENT:STEP:LINK SPAN
FREQ:CENT:STEP:LINK:FACT 50PCT
```



The *X * SPAN* softkey allows the factor defining the center frequency step size to be entered as % of the span.

IEC/IEEE-bus command:

```
FREQ:CENT:STEP:LINK SPAN
FREQ:CENT:STEP:LINK:FACT 20PCT
```

The = *CENTER* softkey sets the step size coupling to *MANUAL* and the step size to the value of the center frequency. This function is especially useful during measurements of the signal harmonic content because by entering the center frequency each stroke of the *STEP* key selects the center frequency of another harmonic.

IEC/IEEE-bus command: `--`

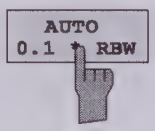
The = *MARKER* softkey sets the step size coupling to *MANUAL* and the step size to the value of the marker. This function is especially useful during measurements of the signal harmonic content at the marker position because by entering the center frequency each stroke of the *STEP* key selects the center frequency of another harmonic.

IEC/IEEE-bus command: `--`

The *MANUAL* softkey activates the window for entering a fixed step size.

IEC/IEEE-bus command: `FREQ:CENT:STEP 120MHz`

Softkeys in time domain:

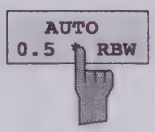


The *0.1 * RBW* softkey sets the step size for the center frequency entry to 10% of the resolution bandwidth.

*AUTO 0.1 * RBW* corresponds to the default setting.

IEC/IEEE-bus command:

```
FREQ:CENT:STEP:LINK RBW
FREQ:CENT:STEP:LINK:FACT 10PCT
```



The *0.5 * RBW* softkey sets the step size for the center frequency entry to 50% of the resolution bandwidth.

IEC/IEEE-bus command:

```
FREQ:CENT:STEP:LINK RBW
FREQ:CENT:STEP:LINK:FACT 50PCT
```

The *X * RBW* softkey allows the factor defining the center frequency step size to be entered as % of the resolution bandwidth.

Values between 1 and 100% in steps of 1% are permissible. The default setting is 10%.

IEC/IEEE-bus command:

```
FREQ:CENT:STEP:LINK RBW
FREQ:CENT:STEP:LINK:FACT 20PCT
```

The *= CENTER* softkey sets the step size coupling to *MANUAL* and the step size to the value of the center frequency. This function is especially useful during measurements of the signal harmonic content because by entering the center frequency each stroke of the *STEP* key selects the center frequency of another harmonic.

IEC/IEEE-bus command: `--`

The *= MARKER* softkey sets the step size coupling to *MANUAL* and the step size to the value of the marker. This function is especially useful during measurements of the signal harmonic content at the marker position because by entering the center frequency each stroke of the *STEP* key selects the center frequency of another harmonic.

IEC/IEEE-bus command: `--`

The *MANUAL* softkey activates the window for entering a fixed step size.

IEC/IEEE-bus command:

```
FREQ:CENT:STEP 120MHz
```

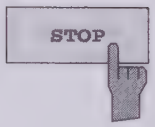
The *START* softkey activates the window for manually entering the start frequency.

The permissible range of values for the start frequency is:

$0\ Hz \leq f_{start} \leq f_{max} - minspan$

f_{start} start frequency
minspan smallest selectable span (10 Hz)
f_{max} max. frequency

IEC/IEEE-bus command: `FREQ:STAR 20MHz`



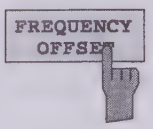
The *STOP* softkey activates the window for entering the .

The permissible range of values for the stop frequency is:

$minspan \leq f_{stop} \leq f_{max}$

f_{stop} stop frequency
minspan smallest selectable span (10 Hz)
f_{max} max. frequency

IEC/IEEE-bus command: `FREQ:STOP 2000MHz`



The *FREQUENCY OFFSET* softkey activates the window for entering an arithmetical frequency offset which is added to the frequency axis labelling. The permissible range of values for the offset is -100 GHz to 100 GHz. The default setting is 0 Hz.

IEC/IEEE-bus command: `FREQ:OFFS 10 MHz`

The *SIGNAL TRACK* softkey switches on the tracking of a signal near the center frequency. The signal is tracked as long it is in the search bandwidth around the center frequency defined with *TRACK BW* and above the level threshold defined with *TRACK THRESHOLD*.
To this end, the maximum signal is searched *(PEAK SEARCH)* on the screen and the center frequency set to this signal *(MARKER ->CENTER)* after each frequency sweep within the search bandwidth.

If the signal falls below the level threshold or jumps out of the search bandwidth around the center frequency, the center frequency is not varied until a signal is in the search bandwidth above the level threshold. This can be achieved by manually modifying the center frequency, for example.

On switching on, the softkey is highlighted and the search bandwidth and the threshold value are marked on the diagram by two vertical lines and one horizontal line. All these lines are allocated the designation TRK.

At the same time a submenu is opened in which the search bandwidth, the threshold value and the trace can be modified for the maximum search.

The softkey is only available in the frequency domain (span >0).

IEC/IEEE-bus command: `CALC:MARK:FUNC:STR OFF`

The *TRACK ON/OFF* softkey switches on and off signal tracking.

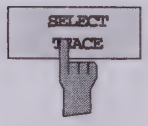
IEC/IEEE-bus command: `CALC:MARK:FUNC:STR OFF`

The *TRACK BW* softkey defines the search bandwidth for signal tracking. The frequency range is symmetrical with respect to the center frequency.

IEC/IEEE-bus command:
`CALC:MARK:FUNC:STR:BAND 10KHZ`

The *TRACK THRESHOLD* softkey defines the threshold value for signal detection. The value is always entered as an absolute level value.

IEC/IEEE-bus command:
`CALC:MARK:FUNC:STR:THR -70DBM`

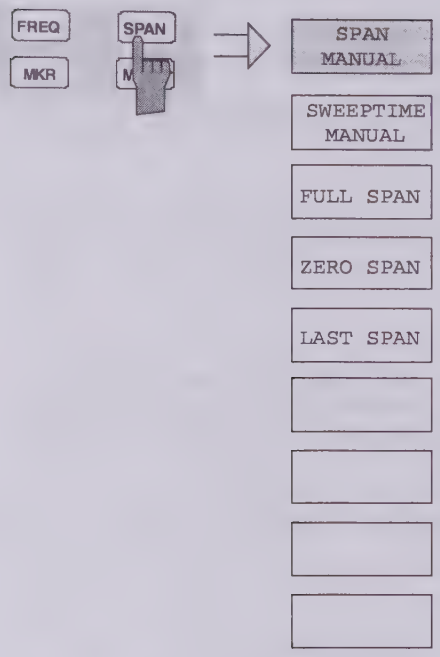


The *SELECT TRACE* softkey selects the trace on which signal tracking is to be performed.

IEC/IEEE-bus command:
`CALC:MARK:FUNC:STR:TRAC 1`

Setting the Frequency Span – *SPAN Key*

SPAN menu



The *SPAN* key opens a menu which offers various options for setting the span.
The entry of the span (*SPAN MANUAL* softkey) is automatically active for span > 0 Hz.
For span = 0 Hz the entry for sweep time (*SWEEPTIME MANUAL*) is automatically active.
With two windows (*SPLIT SCREEN)* displayed at the same time, the input data always refer to the window selected with hotkey *SCREEN A/B*.

The *SPAN MANUAL* softkey activates the window for manually entering the frequency span. The center frequency is kept constant.

The permissible range of span values is:

for the time domain (span = 0): 0 Hz

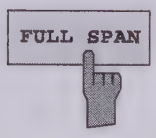
and for the frequency domain (span >0): minspan $\leq f_{span} \leq f_{max}$

f_{span}	frequency span
minspan	smallest selectable span (10 Hz)
f_{max}	max. frequency

IEC/IEEE-bus command `FREQ:SPAN 2GHz`

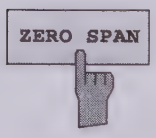
The *SWEEPTIME MANUAL* softkey activates the window for entering the sweep time manually with Span = 0 Hz. The softkey is not available for Span > 0 Hz.

IEC/IEEE-bus command: `SWE:TIME 10s`



The *FULL SPAN* softkey sets the span to the full frequency range of FSP.

IEC/IEEE-bus command `FREQ:SPAN:FULL`



The *ZERO SPAN* softkey sets the span to 0 Hz. The x axis becomes the time axis with the grid lines corresponding to 1/10 of the current sweep time (SWT).

IEC/IEEE-bus command `FREQ:SPAN 0Hz`

After changing the span setting the *LAST SPAN* softkey activates the previous setting. Switchover between overview measurement (*FULL SPAN*) and detailed measurement (manually set center frequency and span) is possible.

Note: *Only values > 0 Hz are restored, i.e. switchover between time and frequency domain is not possible.*

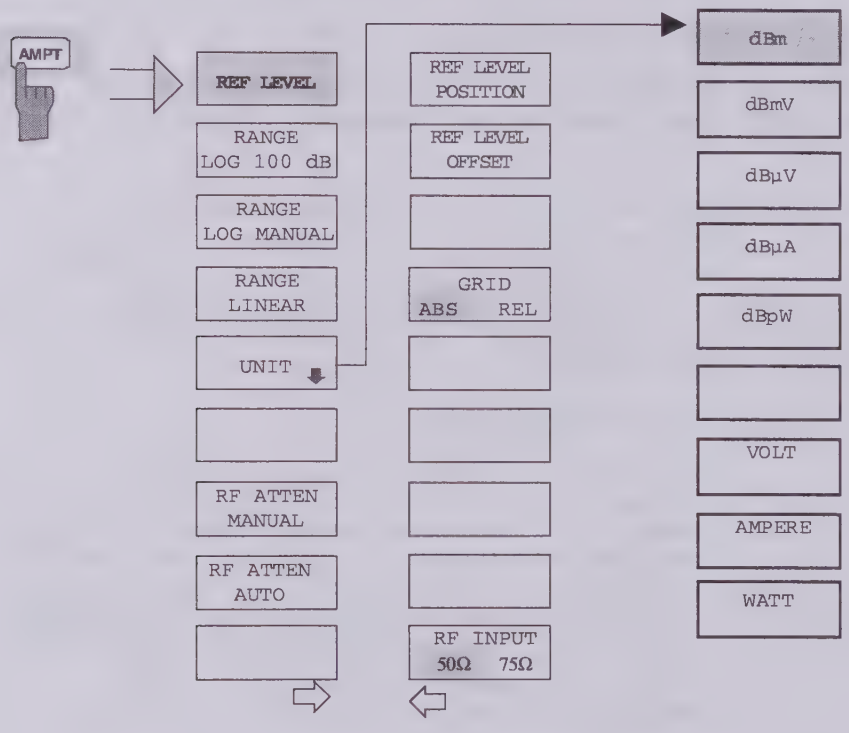
IEC/IEEE-bus command `---`

Level Display Setting and RF Input Configuration –*AMPT Key*

The *AMPT* key is used to set the reference level, the maximum level and the display range of the active window as well as the input impedance and the input attenuation of the RF input.

The *AMPT* key opens a menu for setting the reference level and the input attenuation of the active window. The window for reference level entry (*REF LEVEL* softkey) is opened automatically.

Further settings regarding level display and attenuation can be made in this menu.



The *REF LEVEL* softkey allows the reference level to be input in the currently active unit (dBm, dBµV, etc).

IEC/IEEE-bus command: `DISP:WIND:TRAC:Y:RLEV -60dBm`

The *RANGE LOG 100 dB* softkey sets the level display range to 100 dB.

IEC/IEEE-bus command:
```
DISP:WIND:TRAC:Y:SPAC LOG
DISP:WIND:TRAC:Y 100DB
```

The *RANGE LOG MANUAL* softkey activates the manual entry of the level display range. Display ranges from 10 to 200 dB are allowed in 10 dB steps. Inputs which are not permissible are rounded to the next valid value.

The default setting is 100 dB.

IEC/IEEE-bus command:
```
DISP:WIND:TRAC:Y:SPAC LOG
DISP:WIND:TRAC:Y 120DB
```

The *RANGE LINEAR* softkey switches the display range of the analyzer to linear scaling. The horizontal lines are labelled in %. The grid has a decadic scaling.

IEC/IEEE-bus command:
```
DISP:WIND:TRAC:Y:SPAC LIN
```

The *UNIT* softkey opens a sub menu allowing to select the unit for the level axis.

The default setting is dBm.

In general, the spectrum analyzer measures the signal voltage at the RF input. The level display is calibrated in rms values of an unmodulated sinewave signal. In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input resistance of 50 Ω or 75Ω , conversion to other units is possible. The units dBm, dBmV, dBµV, dBµA, dBpW, V, A and W are directly convertible.

IEC/IEEE-bus command:
```
CALC:UNIT:POW DBM
```

The *RF ATTEN MANUAL* softkey allows the attenuation to be entered irrespective of the reference level.

The attenuation can be set in 10 dB steps between 0 and 70 dB. Other entries will be rounded to the next lower integer value.

If the defined reference level cannot be set for the given RF attenuation, the reference level will be adjusted accordingly and the warning "Limit reached" will be output.

Note: *The 0-dB value can be entered only via the numeric keypad so as to protect the input mixer against inadvertent overload.*

IEC/IEEE-bus command: `INP:ATT 40 DB`

The *RF ATTEN AUTO* softkey sets the RF attenuation automatically as a function of the selected reference level.
This ensures that the optimum RF attenuation desired by the user is always used.

RF ATTEN AUTO is the default setting.

IEC/IEEE-bus command: `INP:ATT:AUTO ON`

AMPT submenu:

The *REF LEVEL POSITION* softkey allows the reference level position to be entered.

The setting range is from -200 to +200%, 0% corresponding to the lower and 100% to the upper limit of the diagram.

IEC/IEEE-bus command: `DISP:WIND:TRAC:RPOS 100PCT`

The *REF LEVEL OFFSET* softkey allows the arithmetic level offset to be entered. This offset is added to the measured level irrespective of the selected unit. The scaling of the Y axis is changed accordingly.

The setting range is ±200 dB in 0.1 dB steps.

IEC/IEEE-bus command: `DISP:WIND:TRAC:RLEV:OFFS -10dB`

The *GRID ABS/REL* softkey switches between absolute and relative scaling of the level axis.

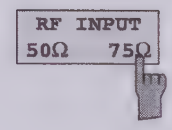
G*RID ABS* is the default setting.

ABS The labelling of the level lines refers to the absolute value of the reference level.

REL The upper line of the grid is always at 0 dB.
The scaling is in dB whereas the reference level is always in the set unit (dBm, dBµV,..).

For setting *RANGE LINEAR* (linear scaling, labelling of axes in %) the softkey is not displayed since the unit % itself implies a relative scale.

IEC/IEEE-bus command: `DISP:WIND:TRAC:Y:MODE ABS`



The *RF INPUT 50 Ω / 75 Ω* softkey switches the input impedance of FSP between 50 Ω (= default setting) and 75 Ω.
All levels specified in this operating manual refer to the default setting of FSP (50 Ω).

IEC/IEEE-bus command: `INP:IMP 50OHM`

Setting the Bandwidths and Sweep Time – *BW* Key

The *BW* key calls a menu for setting the resolution bandwidth (*RBW*), video bandwidth (*VBW*) and sweep time (*SWT*) for the frequency sweep. The parameters may be coupled irrespective of the span (stop minus start frequency) or freely set by the user. When working with a split screen, the settings always relate to the active window.
FSP offers resolution bandwidths from 10 Hz to 10 MHz in 1, 3, 10 steps:

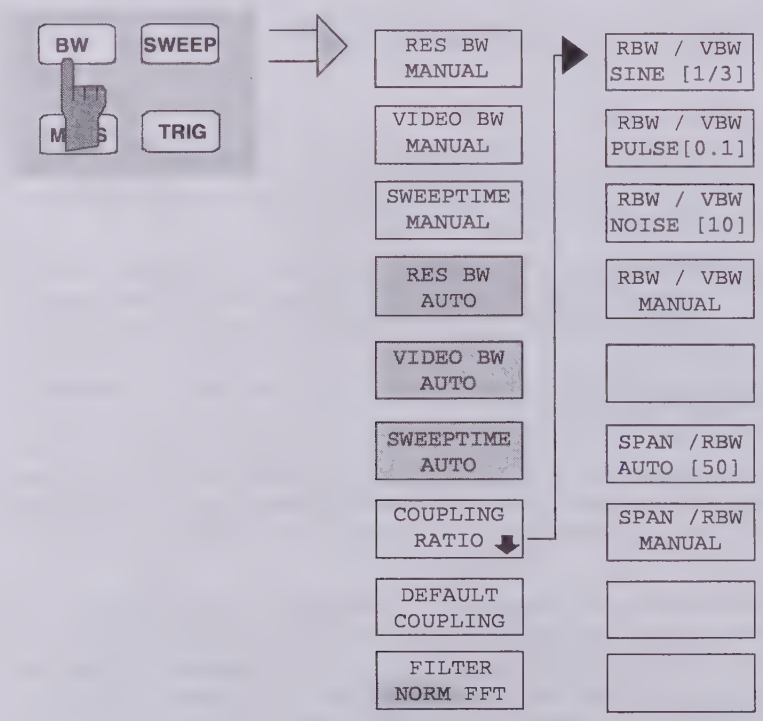
Resolution bandwidths up to 30 kHz are realized using digital bandpasses with Gaussian characteristics. They behave like analog filters.
Bandwidths above 100 kHz are realized using decoupled 4-circuit LC filters.

As an alternative to the digital filters, FFT filters are available for the bandwidths between 1 Hz and 30 kHz.

When working with bandwidths up to 30 kHz, the FFT algorithm offers considerably higher measurement speeds with all the other settings remaining the same. The reason is that with analog filters the sweep time required for a particular span is proportional to (Span/RBW^2). When using the FFT algorithm, however, the sweep time is proportional to (Span/RBW).

The video bandwidths are available in 1/3 steps between 1 Hz and 10 MHz. They can be set in accordance with the resolution bandwidth. The video filters serve for smoothing the displayed trace. Video bandwidths that are small compared to the resolution bandwidth average out peak noise and impulsive signals, so only the signal average is displayed. If impulsive signals are to be measured, it is therefore recommended to use a video bandwidth that is large compared to the resolution bandwidth (VBW ≥ 10 x RBW) for the amplitudes of pulses to be measured correctly.

BW menu:

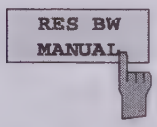


The *BW* key calls a menu for setting the resolution bandwidth, video bandwidth, sweep time and their couplings.

The various .. *AUTO* softkeys are used to couple the functions. The coupling ratios are selected by the *COUPLING RATIO* softkey.

The .. *MANUAL* softkeys enable the entry of the parameter concerned. This parameter is not coupled to the other parameters.

Note: *With the ... BW AUTO softkeys the resolution bandwidth, the video bandwidth and the sweep can be entered separately for the frequency domain (span > 0 Hz) and the time domain (span = 0 Hz).*
But with ...BW MANUAL softkeys the set values apply to both the frequency and time domain.

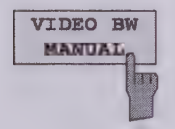


The *RES BW MANUAL* softkey activates the manual entry mode for the resolution bandwidth.

The resolution bandwidth can be set in 1/3/10 steps in the range between 10 Hz and 10 MHz. The nominal resolution bandwidth is the 3 dB bandwidth. When FFT filters are used, the lower limit of the bandwidth is 1 Hz. FFT filters may be used with bandwidths up to 30 kHz.
For numerical inputs, the values are always rounded to the next permissible bandwidth. For rollkey or UP/DOWN key inputs, the bandwidth is adjusted in steps either upwards or downwards.

The manual input mode of the resolution bandwidth is indicated by a green asterix (*) on the display.

IEC/IEEE-bus command:
```
BAND:AUTO OFF;
BAND 1MHz
```



The *VIDEO BW MANUAL* softkey activates the manual input mode for the video bandwidth.

The video bandwidth can be set in 1/3 steps in the range between 1 Hz and 10 MHz.
For numerical inputs, rounding is made to the next permissible bandwidth. For rollkey or UP/DOWN key inputs, the bandwidth is adjusted in steps either downwards or upwards.
The manual input mode of the video bandwidth is indicated by a green asterix (*) on the display.

IEC/IEEE-bus command:
```
BAND:VID:AUTO OFF;
BAND:VID 10 kHz
```

The *SWEEPTIME MANUAL* softkey activates the manual input mode for the sweep time. At the same time, the coupling of the sweep time is cancelled. Other couplings (*VIDEO BW, RES BW*) remain effective.

In the frequency domain (span > 0 Hz) and for resolution bandwidths above 1 kHz, the allowed sweep times for spans > 3.2 kHz range from 2.5 ms through to 16000 s. With spans below 3.2 kHz, the maximum permissible sweep time is reduced to 5 s * span/Hz.
If FFT filters are used, the sweep time is fixed by the span and the bandwidth and therefore cannot be set.
For displays in the time domain (span = 0 Hz), the range of sweep times 1 µs to 16000 s is selectable in steps of max. 5% of the sweep time. For numerical inputs, rounding is made to the next permissible sweep time. For rollkey or UP/DOWN key inputs, the sweep time is adjusted in steps either downwards or upwards.

The manual input mode of the sweep time is indicated by a green asterix (*) on the display. If the selected sweep time is too short for the selected span and bandwidth, level measurement errors will occur. This happens because the available settling time for the resolution or video filters is too short. In this case, FSP outputs *UNCAL* on the display and marks the indicated sweep time with a red asterix (*).

IEC/IEEE-bus command:
```
SWE:TIME:AUTO OFF;
SWE:TIME 10s
```

The *RES BW AUTO* softkey couples the resolution bandwidth to the selected span. Changing the span causes automatic adjustment of the resolution bandwidth.

Automatic coupling of resolution bandwidth to span is always recommended when a favourable setting of the resolution bandwidth in relation to the selected span is desired to match the measurement on hand.

The coupling ratio is set in the *COUPLING RATIO* submenu.

The *RES BW AUTO* softkey is only available in the frequency domain (span > 0 Hz). The softkey is blanked in the time domain.

IEC/IEEE-bus command: `BAND:AUTO ON`

The *VIDEO BW AUTO* softkey couples the video bandwidth to the resolution bandwidth. If the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

The coupling of the video bandwidth is always recommended when the maximum sweep time is to be achieved for a selected resolution bandwidth. Narrower video bandwidths require longer sweep times due to the longer settling time. Wider bandwidths reduce the signal/noise ratio.

The coupling ratio is set in the *COUPLING RATIO* submenu.

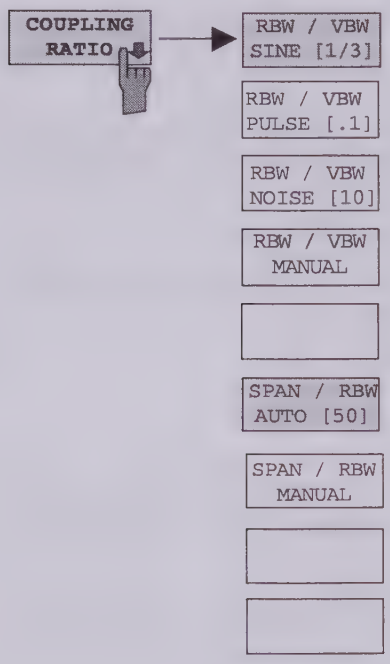
The coupling of the video bandwidth to the resolution filter is also permitted for the time domain display (span = 0).

IEC/IEEE-bus command: `BAND:VID:AUTO ON`

The *SWEEPTIME AUTO* softkey couples the sweep time to the span, video bandwidth (VBW) and resolution bandwidth (RBW). The sweep time is automatically matched to any change in span, resolution bandwidth or video bandwidth.

The softkey is only available in the frequency domain (span >0 Hz). It is blanked in the time domain.
FSP always selects the shortest sweep time possible without falsifying the signal. The maximum level error compared to when a longer sweep time is used is < 0.1 dB. If additional bandwidth and level errors are to be avoided, the sweep time is to be set to three times the time offered in the coupled mode.

IEC/IEEE-bus command: `SWE:TIME:AUTO ON`



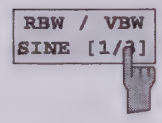
The *COUPLING RATIO* softkey switches to a sub menu for selection of the coupling ratios.

When the default setting is active, ie the *COUPLING RATIO* softkey is deactivated (not highlighted), the ratio span/resolution bandwidth (SPAN/RBW) is 50 and the ratio resolution bandwidth/video bandwidth (RBW/VBW) is 0.33.

If the ratio RBW/VBW or SPAN/RBW is not the default setting, the *COUPLING RATIO* softkey is highlighted.

The softkeys RBW/VBW... are selection keys. Only one softkey can be anabled at any one time. The softkeys are only effective for the *VBW AUTO* selection in the main menu.

The softkeys SPAN/RBW... are also selection keys. They are only effective for the *RBW AUTO* selection in the main menu.



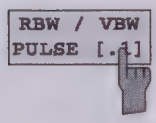
The *RBW/VBW SINE [1/3]* softkey sets the video bandwidth equal to the resolution bandwith:
video bandwidth = 3 x resolution bandwidth.

This is the default setting for the coupling ratio resolution bandwidth/video bandwidth.

This is the coupling ratio recommended if sinusoidal signals are to be measured.

IEC/IEEE-bus command `BAND:VID:RAT 3`

This setting is only effective for the *VBW AUTO* selection in the main menu.

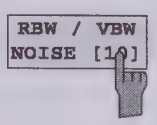


The *RBW/VBW PULSE [.1]* softkey sets the following coupling ratio:
video bandwidth = 10 x resolution bandwidth or
video bandwidth = 1 MHz (= max. VBW).

This coupling ratio is recommended whenever the amplitudes of impulsive signals are to be measured correctly. The IF filter is exclusively responsible for pulse shaping. No additional evaluation is performed by the video filter.

IEC/IEEE-bus command `BAND:VID:RAT 10`

This setting is only effective for the *VBW AUTO* selection in the main menu.

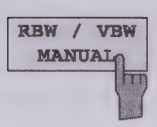


The *RBW/VBW NOISE [10]* softkey sets the following coupling ratio:
video bandwidth = resolution bandwidth/10

At this coupling ratio, noise and impulsive signals are suppressed in the video domain. For noise signals, the average value is displayed.

IEC/IEEE-bus command `BAND:VID:RAT 0.1`

This setting is only effective for the *VBW AUTO* selection in the main menu.

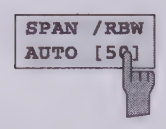


The *RBW/VBW MANUAL* softkey activates the manual input of the coupling ratio.

The ratio resolution bandwidth/video bandwidth can be set in the range 0.001 to 1000.

IEC/IEEE-bus command `BAND:VID:RAT 10`

This setting is only effective for the *VBW AUTO* selection in the main menu.



The *SPAN/RBW AUTO [50]* softkey sets the following coupling ratio:
resolution bandwidth = span/50

This coupling ratio is the default setting of the FSP.

IEC/IEEE-bus command `BAND:RAT 0.02`

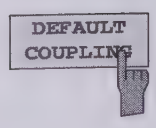
This setting is only effective for the *RBW AUTO* selection in the main menu.

The *SPAN/RBW MANUAL* softkey activates the manual input of the coupling ratio.

The ratio span / resolution bandwidth can be set in the range 1 to 10000.

IEC/IEEE-bus command `BAND:RAT 0.1`

This setting is only effective for the *RBW AUTO* selection in the main menu.



The *DEFAULT COUPLING* softkey sets all coupled functions to the default state (*AUTO*). In addition, the ratio *RBW/VBW* is set to *SINE [1/3]* and the ratio *SPAN/RBW* to 50 in the *COUPLING RATIO* submenu (default setting, *COUPLING RATIO* softkey not highlighted).

IEC/IEEE-bus command
```
BAND:AUTO ON
BAND:VID:AUTO ON
SWE:TIME:AUTO ON
```

The *FILTER NORM/FFT* softkey switches between bandpass and filtering with FFT algorithm.

NORM For resolution bandwidths up to 30 kHz bandpassess are used.

FFT An FFT is performed. To this end, the filtered IF signal is digitized and then transformed into the spectral domain via FFT. The transformation range depends on the selected filter bandwidths and can be set between 4 kHz to 50 kHz. If the span is larger than the transformation range, several transformations are performed and the results are appended to each other in the spectral domain. If the span is smaller than the transformation range, the measurement results are interpolated when the number of measurement points provided by the FFT is smaller than the number of display points in x-direction (501). A flattop window serves as a window in the time domain so that high amplitude precision with good selection is achieved.

Sweep time	Defined through selected bandwidth and span (reason: FFT filtering is a block transformation). It cannot be changed (softkey deactivated).
Detector	Sample detector and peak detector are available. Peak detector is active when AUTO SELECT is selected.
Video bandwidth	Not defined in case of FFT; cannot therefore be set (softkeys deactivated).

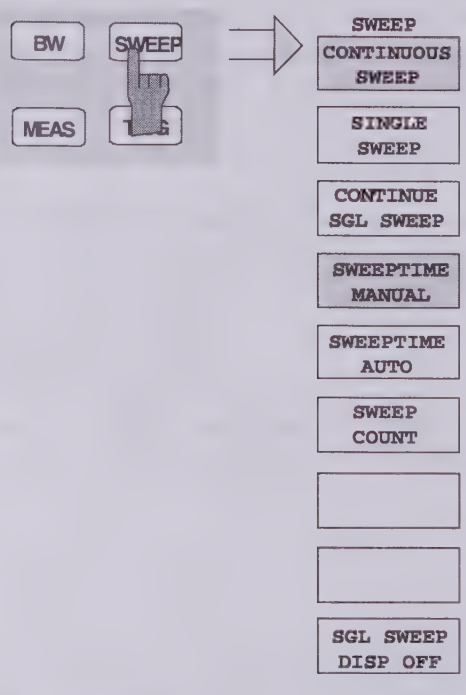
Compared to bandpasses, FFT filters lead to markedly reduced sweep times. For a span of 50 kHz and a bandwidth of 100 Hz, for instance, the sweep time is reduced from 5 s to 40 ms. FFT filters are particularly suitable for stationary signals (sinusoidal signals or signals that are continuously modulated in time). For burst signals (TDMA) or impulsive signals, fixed filters are preferable. FFT is a block transformation so the result depends on the time relation between the dataset to be transformed and the burst or impulsive signal. A gated sweep measurement for TDMA signals is therefore not provided if FFT filters are used.

IEC/IEEE-bus command `BAND:MODE:FFT ON`

Sweep Settings – *SWEEP* Key

The SWEEP key serves for configuring the sweep mode.

SWEEP menu



The *SWEEP* key calls a menu in which the sweep mode is defined. In split-screen mode, the entries made are valid for the active window only.

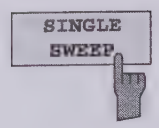
The *CONTINUOUS SWEEP, SINGLE SWEEP* and *SGL SWEEP DISP OFF* softkeys are mutually exclusive selection keys.

The *CONTINUOUS SWEEP* softkey activates the continuous sweep mode, which means that the sweep takes place continuously according to the trigger mode set.

When working in the split-screen mode and with different settings in the two windows, screen A is swept first, followed by screen B. When the softkey is pressed, the sweep is restarted.

CONTINUOUS SWEEP is the default setting of FSP.

IEC/IEEE-bus command: `INIT:CONT ON`

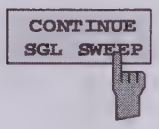


The *SINGLE SWEEP* softkey starts n sweeps after triggering. The number of sweeps is determined by the *SWEEP COUNT* softkey.

When working in the split-screen mode, the frequency ranges of the two windows are swept one after the other.

If a trace is swept using *TRACE AVERAGE* or *MAXHOLD,* the value set via the SWEEP COUNT softkey determines the number of sweeps. If 0 has been entered, one sweep is performed.

IEC/IEEE-bus command: `INIT:CONT OFF`



The *CONTINUE SGL SWEEP* softkey repeats the number of sweeps set under *SWEEP COUNT*, however without first deleting the trace.

This is particularly of interest when using the functions *TRACE AVERAGE* and *MAXHOLD*, if previously recorded measurement results are to be taken into consideration for averaging / maximum search.

If *SGL SWEEP DISP OFF* is active, the screen is switched off also during repeated sweeps.

IEC/IEEE-bus command: `INIT:CONT ONCE`

The *SWEEPTIME MANUAL* softkey activates the window for entering the sweep time manually (see also BW menu).

IEC/IEEE-bus command: `SWE:TIME 10s`

The *SWEEPTIME AUTO* softkey activates the automatic selection of the sweep time as a function of the bandwidth of the resolution and video filters (see also BW menu).

IEC/IEEE-bus command: `SWE:TIME:AUTO ON`

The *SWEEP COUNT* softkey activates the window for the entry of the number of sweeps to be performed by FSP after a single sweep has been started. If Trace Average, Max Hold or Min Hold is activated, this also determines the number of averaging or maximum search procedures.

Example:
[**TRACE1**: *MAX HOLD*]
[**SWEEP**: *SWEEP COUNT*: {10} **ENTER**]
[*SINGLE SWEEP*]

FSP performs the Max Hold function over 10 sweeps.

The permissible range for the sweep count is 0 to 32767. For sweep count = 0 or 1, one sweep is performed. For trace averaging in the continuous-sweep mode, FSP performs running averaging over 10 sweeps if sweep count = 0; if sweep count = 1, no averaging is performed.

The sweep count is valid for all the traces in a diagram.

Note: *The number of sweeps set in the TRACE menu is the same as that in the SWEEP menu.*
If SINGLE SWEEP is selected, the measurement stops after the selected number of sweeps has been performed.

IEC/IEEE-bus command: `SWE:COUN 64`

The *SGL SWEEP DISP OFF* softkey deactivates the display while a single sweep is being performed. Once the sweep has been completed, the trace is shown.

IEC/IEEE-bus command: `INIT:DISP OFF;:INIT.04`

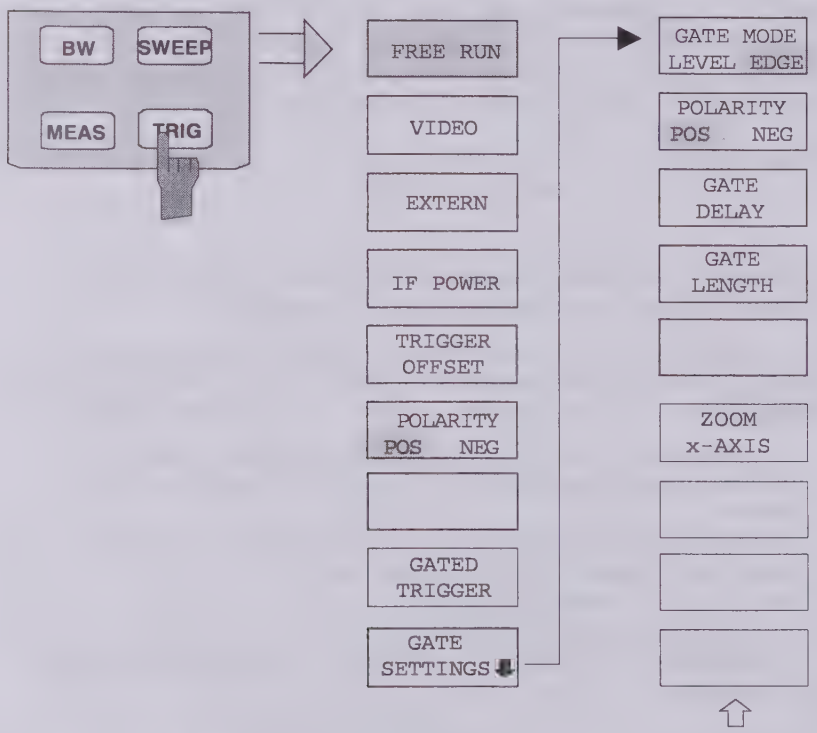
Triggering the Sweep– *TRIG* Key

The *TRIG* key opens a menu for selection of the various trigger sources, trigger polarity and external gate function. The active trigger mode is indicated by highlighting the corresponding softkey.

For video trigger, a trigger threshold can be entered, which is represented in the diagram as a horizontal line.

To indicate that a trigger mode other than *FREE RUN* has been set, the enhancement label **TRG** is displayed on the screen. If two windows are displayed, TRG appears next to the appropriate window.

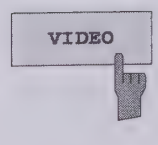
TRIGGER menu



The *FREE RUN* softkey activates the free-run sweep mode, ie start of a sweep is not triggered. Once a measurement is completed, another is started immediately.

FREE RUN is the default setting of FSP.

IEC/IEEE-bus command: `TRIG:SOUR IMM`



The *VIDEO* softkey activates triggering through the displayed voltage.

For the video triggering mode, a horizontal trigger line is shown in the diagram. It may be used to set the trigger threshold between 0% and 100% of the overall diagram height.

IEC/IEEE-bus command:
```
TRIG:SOUR VID
TRIG:LEV:VID 50 PCT
```

The *EXTERN* softkey activates triggering via a TTL signal at the input connector *EXT TRIGGER/GATE* on the rear panel.

IEC/IEEE-bus command:
```
TRIG:SOUR  EXT
SWE:EGAT:SOUR  EXT
```

The *IF POWER* softkey activates triggering of the measurement via signals which are outside the measurement channel.

FSP uses a level detector at the second intermediate frequency. The detector threshold is approximately -20 dBm at the input mixer. This means that the actual trigger level at the RF input is approx. -20 dBm plus the set RF attenuation.
The bandwidth at the intermediate frequency is 10 MHz. Triggering takes place when the trigger threshold is exceeded within a 5 MHz bandwidth about the selected frequency (= start frequency in the frequency sweep). Thus, the measurement of spurious emissions, eg for pulsed carriers, is possible even when the carrier lies outside the selected frequency span.

IEC/IEEE-bus command:
```
TRIG:SOUR  IFP
SWE:EGAT:SOUR  IFP
```

The *TRIGGER OFFSET* softkey activates the window for entering the time offset between the trigger signal and the start of the sweep.

Triggering is delayed by the entered time with respect to the trigger signal (time entered > 0) or is started earlier (time entered < 0). The time may be entered in multiples of 125 ns in the range -100 s to 100 s (default 0 s).

Note: *A negative offset (pretrigger) can be set in the time domain only (SPAN = 0 Hz) provided GATED TRIGGER is not active in that domain.*
The maximum permissible range and the maximum resolution of the pretrigger is limited by the set sweep time:
max. range = - 499/500 x sweep time
max. resolution = sweep time/500.
Pretriggering is not possible when the rms or the average detector is activated.

As a common input signal is used for both trigger and gate when selecting *EXTERN* and *IF POWER*, changes to the gate delay will affect the trigger delay *(TRIGGER OFFSET)* as well.

IEC/IEEE-bus command:
```
TRIG:HOLD  10US
```

The *POLARITY POS/NEG* softkey selects the polarity of the trigger source.

The sweep starts after a positive or negative edge of the trigger signal. The selected setting is highlighted.

The selection is valid for all trigger modes with the exception of *FREE RUN*; in the gate mode, it also applies to the gate polarity.

The default setting is *POLARITY POS*.

IEC/IEEE-bus command:
```
TRIG:SLOP  POS
```

By using a gate in sweep mode and stopping the measurement while the gate signal is inactive, the spectrum for pulsed RF carriers can be displayed without the superposition of frequency components generated during switching. Similarly, the spectrum can also be examined for an inactive carrier. The sweep can be controlled by an external gate or by the internal power trigger.

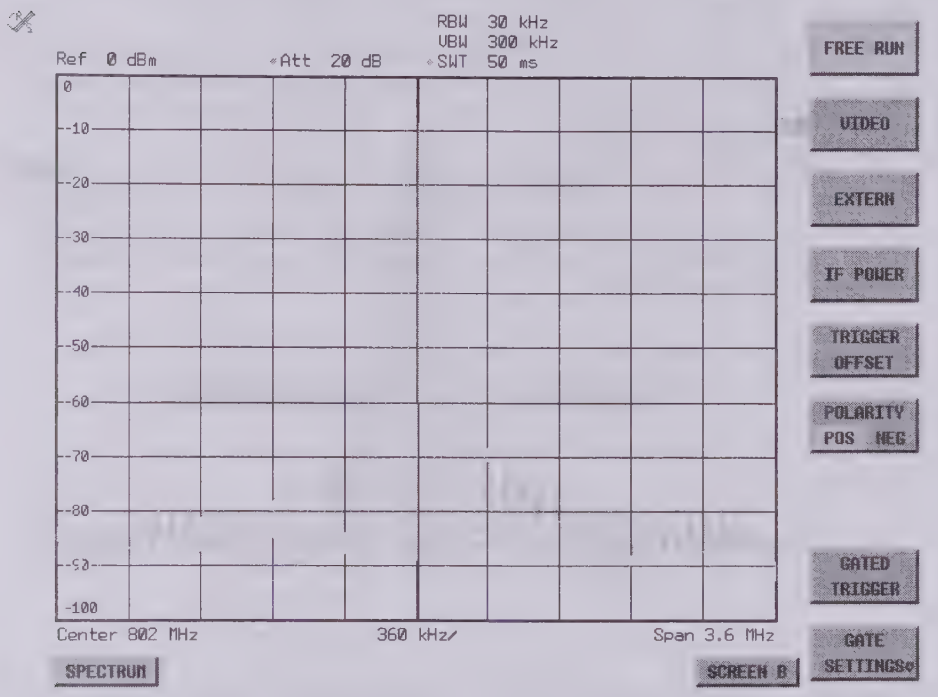


Fig. 4-1 Pulsed signal GATE OFF

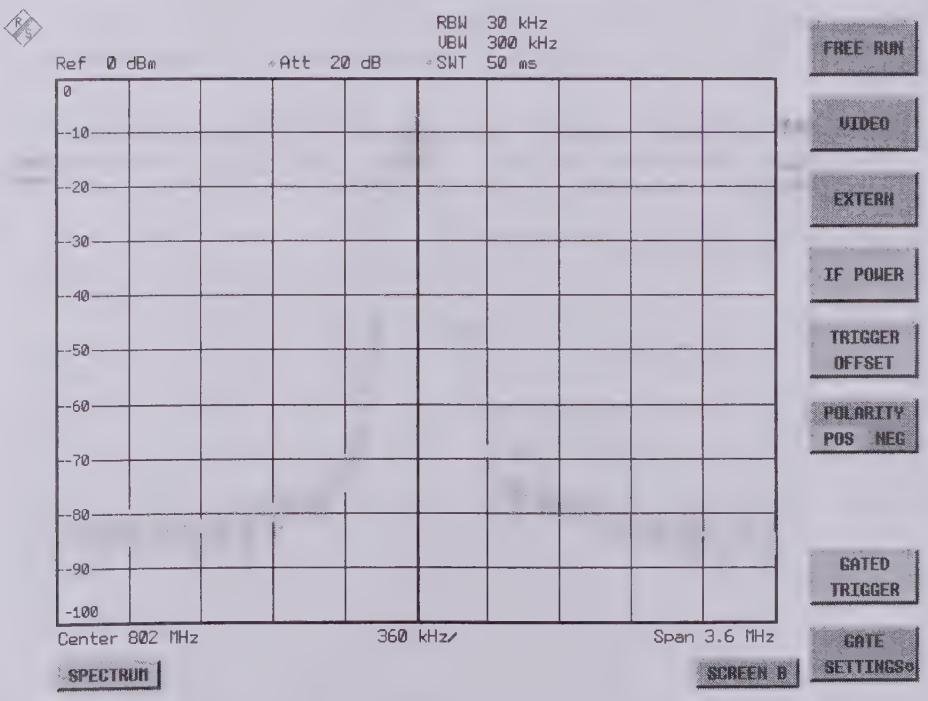


Fig. 4-2 TDMA signal with GATE ON

The *GATE DELAY* softkey activates the window for setting the delay time between the gate signal and the continuation of the sweep.

This may be useful for taking into account a delay between the gate signal and the stabilization of an RF carrier for example.

As gate delay, values between 125 ns and 100 s may be set. The position of the delay on the time axis in relation to the sweep is indicated by the line labelled **GD**.

As there is a common input signal for trigger and gate if *EXTERN* or *IF POWER* is selected, changes to the gate delay will affect the trigger delay (*TRIGGER OFFSET*) as well.

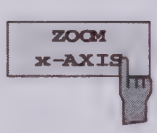
IEC/IEEE-bus command: `SWE:EGAT:HOLD 1US`

The *GATE LENGTH* softkey activates the window for setting the sweep duration of FSP in the edge-triggered mode.

Values between 125 ns and 100 s may be set for the gate length. The length of the gate in relation to the sweep is indicated by the line labelled **GL**.

This softkey is only available if *GATE MODE EDGE* (edge triggering) has been selected.

IEC/IEEE-bus command: `SWE:EGAT:LENG 100US`



The *ZOOM x-AXIS* softkey enables the user to change the time axis to obtain a higher resolution for positioning gate delay and gate length.
When this is to be done, the sweep time temporarily changes; the original value is restored when the menu is quit.

IEC/IEEE-bus command: `--`

Measurement example:

The modulation spectrum of a GSM or PCS1900 signal is to be measured using the gated-sweep function. The signal is generated by a Signal Generator SME03 whose RF output is directly connected to the RF input of FSP.

Settings on SME03:

FREQ:	802 MHz
Level:	0 dBm: Return
Digital Mod:	Select: GMSK: Select
Source:	Select: PRBS: Select: Return
Level Attenuation:	Select: 60 dB: Return

The SME03 supplies a GMSK-modulated TDMA signal (GSM).

Settings on FSP:

Conventions:

[KEY]	Menu called by this key. All information between the brackets refers to this menu.
{Number}	Numeric value to be entered for the parameter on hand.
SOFTKEY	Softkey to be used for making a selection or entering a value.

[PRESET]
[FREQ: *CENTER* {802} **MHz]**
[SPAN {3.6} **MHz]**
[AMPT: *REF LEVEL* {0} **dBm**: *RF ATTEN MANUAL*: {10} **dB]**
[BW: *RES BW MANUAL*: {30} **kHz]**
[TRACE : *TRACE 1* *DETECTOR*: *RMS]*
[SWEEP: *SWEEPTIME MANUAL*: {50} **ms]**
[TRIG: *EXTERN*
GATED TRIGGER;
GATE SETTINGS: *GATE MODE EDGE; POLARITY POS*
SWEEPTIME MANUAL {1} **ms**: *GATE DELAY* {300} **µs**:
GATE LENGTH: {250} **µs]**

The following figure shows the screen display for setting gate parameters. The vertical lines for gate delay (GD) and gate length (GL) can be adjusted to the burst signal by entering numeric values or by means of the rollkey.

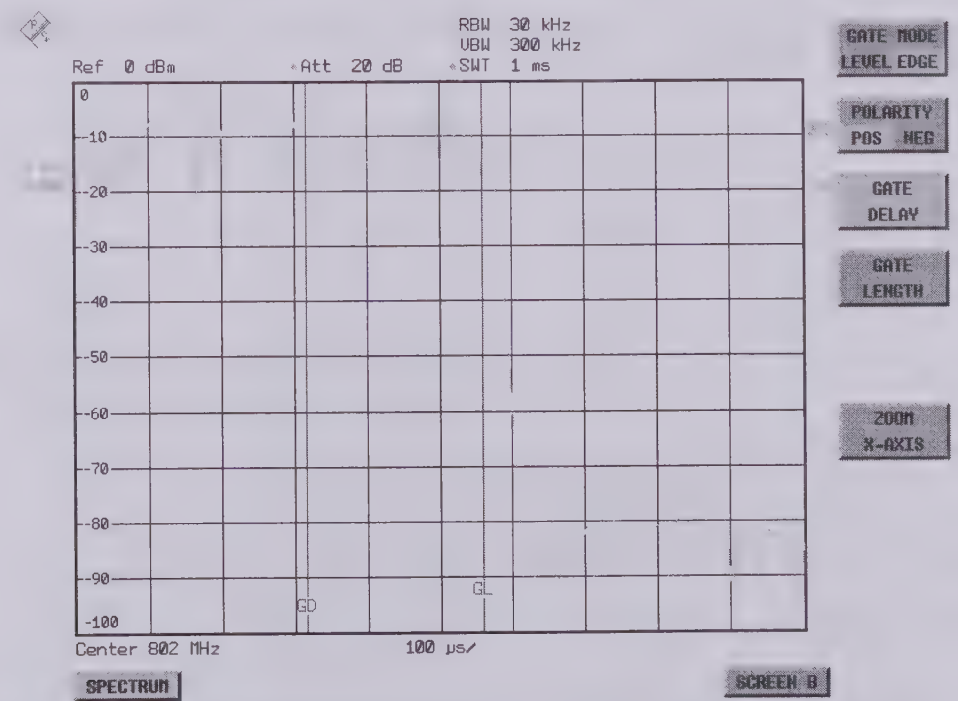


Fig.4-4 Setting GATE DELAY and GATE LENGTH in time domain by means of lines GD and GL

On quitting the *GATE SETTINGS* menu, FSP returns to the previous screen.

Selection and Setting of Traces – *TRACE* Key

FSP is capable of displaying up to three different traces at a time in a diagram. A trace consists of a maximum of 501 pixels on the horizontal axis (frequency or time). If more measured values than pixels are available, several measured values are combined in one pixel.
The traces are selected using the *SELECT TRACE* softkey in the menu of the *TRACE* key.

The traces can individually be activated for a measurement or frozen after completion of a measurement. Traces that are not activated are blanked.

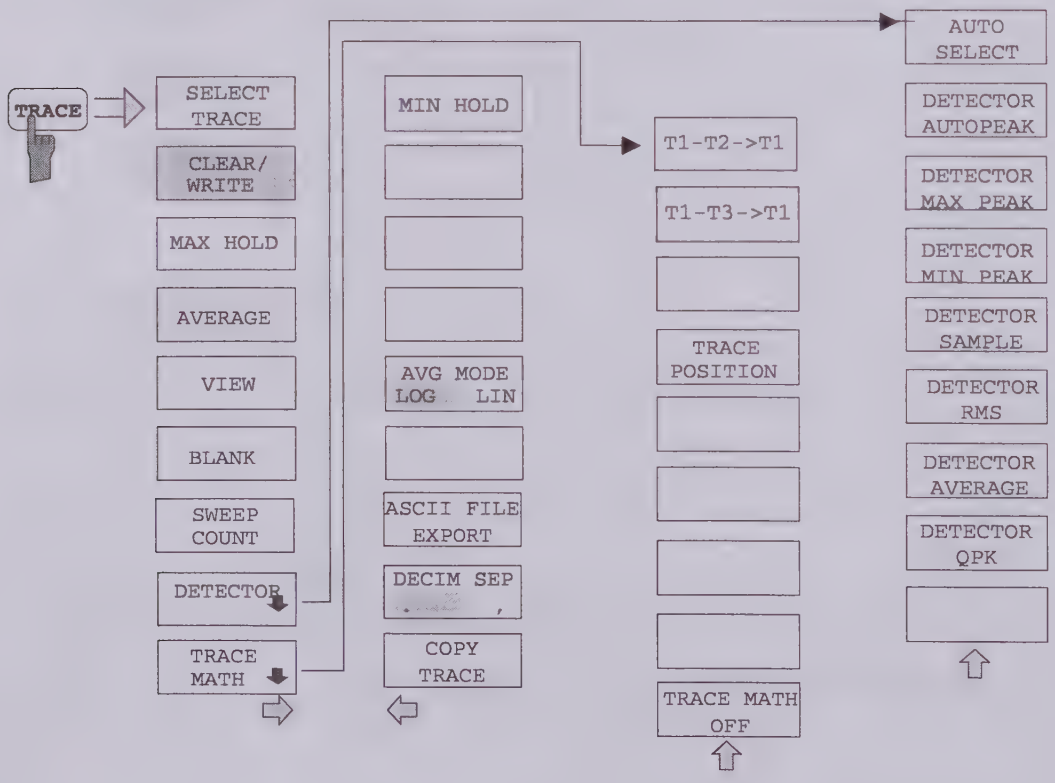
The display mode can be selected for each trace. Traces can be overwritten in each measurement (CLEAR/WRITE mode), averaged over several measurements (AVERAGE mode), or a maximum or minimum value can be determined from several measurements and displayed (MAX HOLD or MIN HOLD).
Individual detectors can be selected for the various traces. The autopeak detector displays maximum and minimum values connected by a vertical line. The max peak detector and min peak detector display the maximum and minimum value of the level within a pixel. The sample detector displays the instantaneous value of the level at a pixel. The rms detector displays the power (rms value) of the measured values within a pixel, the average detector the average value.

Selection of Trace Function

The trace functions are subdivided as follows:

- Display mode of trace (CLEAR/WRITE, VIEW and BLANK)
- Evaluation of the trace as a whole (AVERAGE, MAX HOLD and MIN HOLD)
- Evaluation of individual pixels of a trace (AUTOPEAK, MAX PEAK, MIN PEAK, SAMPLE, RMS, AVERAGE and QUASIPEAK)

TRACE menu



The *TRACE* key opens a menu offering the setting options for the selected trace.

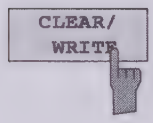
In this menu, the mode of representing the measured data in the frequency or time domain in the 501 pixels of the display is determined. Upon start of the measurement, each trace can be displayed either completely new or based on the previous results.
Traces can be displayed, blanked and copied. Traces can also be corrected with the aid of mathematical functions.
The measurement detector for the individual display modes can be selected directly by the user or set automatically by FSP.

The default setting is trace 1 in the overwrite mode (*CLEAR / WRITE*), the other traces 2 and 3 are switched off (*BLANK*).

The *CLEAR/WRITE, MAX HOLD, MIN HOLD, AVERAGE, VIEW* and *BLANK* softkeys are mutually exclusive selection keys.

The *SELECT TRACE* softkey activates the entry for the active trace (1, 2, 3).

IEC/IEEE-bus command -- (selected via numeric suffix of `:TRACe`)



The *CLEAR/WRITE* softkey activates the overwrite mode for the collected measured values, ie the trace is overwritten by each sweep.

In the *CLEAR/WRITE* display mode all the available detectors can be selected. In the default mode the autopeak detector (setting *AUTO*) is selected.

Each time the *CLEAR/WRITE* softkey is actuated, FSP clears the selected trace memory and starts the measurement anew.

IEC/IEEE-bus command `DISP:WIND:TRAC:MODE WRIT`

The *MAX HOLD* softkey activates the max peak detector.
FSP saves the sweep result in the trace memory only if the new value is greater than the previous one.

The detector is automatically set to *MAX PEAK*. The maximum value of a signal can thus be determined over several sweeps.

This is especially useful with modulated or impulsive signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope.

Pressing the *MAX HOLD* softkey again clears the trace memory and restarts the max hold mode.

IEC/IEEE-bus command `DISP:WIND:TRAC:MODE MAXH`

The *AVERAGE* softkey activates the trace averaging function. The average is formed over several sweeps. Averaging can be performed with any of the detectors available. If the detector is automatically selected by FSP, the sample detector is used.

Depending on the setting of AVG MODE LOG / LIN, the logarithmic level values or the measured power/voltage values are averaged.

Averaging is restarted every time the *AVERAGE* softkey is pressed. The trace memory is always cleared.

IEC/IEEE-bus command `DISP:WIND:TRAC:MODE AVER`

Description of averaging

Averaging is carried out over the pixels derived from the measurement samples. Several measured values may be combined in a pixel. This means that with linear level display the average is formed over linear amplitude values and with logarithmic level display over levels. For this reason the trace must be measured again when changing between *LIN* and *LOG* display mode. The settings *CONT/SINGLE SWEEP* and running averaging apply to the average display analogously.

There are two methods for calculating the average. For a sweep count = 0 , a running average is calculated according to the following formula:

$$\mathrm{TRACE} = \frac{9 * \mathrm{TRACE} + \mathrm{meas.\ value}}{10}$$

Due to the weighting between the new measured value and the trace average, past values have practically no influence on the displayed trace after about ten sweeps. With this setting, signal noise is effectively reduced without need for restarting the averaging process after a change of the signal.

If the sweep count is >1, averaging takes place over the selected number of sweeps. In this case the displayed trace is determined during averaging according to the following formula:

$$\mathrm{Trace}_n = \frac{1}{n}\left[\sum_{i=1}^{n-1}(T_i) + \mathrm{meas.value}_n\right]$$

where n is the number of the current sweep (n = 2 ... SWEEP COUNT). No averaging is carried out for the first sweep but the measured value is stored in the trace memory. With increasing n, the displayed trace is increasingly smoothed since there are more single sweeps for averaging.

After the selected number of sweeps the average trace is saved in the trace memory. Until this number of sweeps is reached, a preliminary average is displayed.

After completion of averaging, ie when the averaging length defined by *SWEEP COUNT* is attained, a running averaging is continued with *CONTINUOUS SWEEP* according to the following formula:

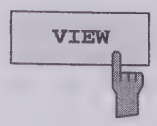
$$\mathrm{Trace} = \frac{(N-1)\cdot \mathrm{Trace_{old}} + \mathrm{meas.value}}{N}$$

where

Trace = new trace
$\mathrm{Trace_{old}}$ = old trace
N = SWEEP COUNT

The display "Sweep N of N" does not change any more until a new start is triggered.

In the *SINGLE SWEEP* mode, the number of sweeps is triggered with *SWEEP START*. The sweeps are stopped when the selected number of sweeps is attained. The number of the current sweep and the total number of sweeps are shown on the display: "Sweep 3 of 200".



The *VIEW* softkey freezes the current contents of the trace memory and displays it.

If a trace is frozen by *VIEW*, the instrument settings can be changed without the displayed trace being modified (exception: level display range and reference level, see below). The fact that the trace and the current instrument setting do not agree any more is indicated by an enhancement label "*" at the right edge of the grid.

If in the *VIEW* display mode the level display range (*RANGE*) or the reference level (*REF LEVEL*) are changed, FSP automatically adapts the measured data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

IEC/IEEE-bus command `DISP:WIND:TRAC:MODE VIEW`

The *BLANK* softkey activates the blanking of the trace on the screen.

IEC/IEEE-bus command `DISP:WIND:TRAC OFF`

The *SWEEP COUNT* softkey activates the entry of the number of sweeps used for averaging. The permissible range of values is 0 to 30000 and the following should be observed:

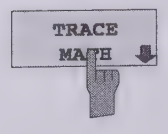
- Sweep Count = 0 means running averaging
- Sweep Count = 1 means no averaging being carried out
- Sweep Count > 1 means averaging over the selected number of sweeps; in the continuous sweep mode averaging is performed until the set number of sweeps is attained and is then continued as running averaging.

The default setting is running averaging (Sweep Count = 0). The number of sweeps used for averaging is the same for all active traces in the selected diagram.

Note: *The setting of the sweep count in the trace menu is equivalent to the setting in the sweep menu.*

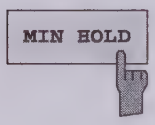
IEC/IEEE-bus command `SWE:COUN 64`

See following Section "Selection of Detector"



See following Section "Mathematical Functions for Traces"

TRACE side menu



The *MIN HOLD softkey* activates the min peak detector. FSP saves for each sweep the smallest of the previously stored/currently measured values in the trace memory. The detector is automatically set to *MIN PEAK*. In this way, the minimum value of a signal can be determined over several sweeps.

This function is useful eg for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed by the min hold function whereas a CW signal is recognized by its constant level.

Pressing the *MIN HOLD* softkey again clears the trace memory and restarts the min hold function.

IEC/IEEE-bus command `DISP:WIND:TRAC:MODE MINH`

The *AVG MODE LOG/LIN* softkey selects logarithmic or linear averaging for the logarithmic level display mode.

At the same time the difference calculation is switched between linear and logarithmic in submenu *TRACE MATH*.

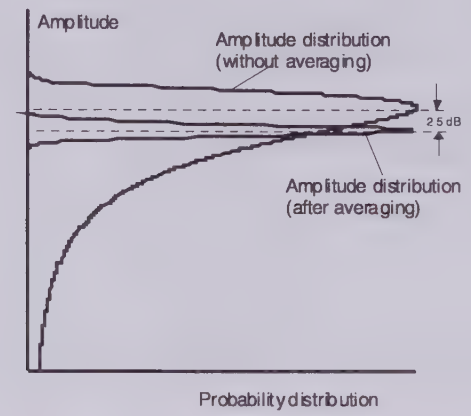
IEC/IEEE-bus command `CALC:MATH:AVER:MODE LIN`

With logarithmic averaging, the dB values of the display voltage are averaged or substracted from each other with trace mathematical functions. With linear averaging the level values in dB are converted into linear voltages or powers prior to averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals the two methods yield the same result.

Logarithmic averaging bzw. Verrechnung is recommended if sinewave signals are to be clearly visible against noise since with this type of averaging noise suppression is improved while the sinewave signals remain unchanged.

For noise or pseudo-noise signals the positive peak amplitudes are decreased in logarithmic averaging due the characteristic involved and the negative peak values are increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.



This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore, FSP offers switchover to linear averaging. The trace data are delogarithmized prior to averaging, then averaged and logarithmized again for display on the screen. The average value is always correctly displayed irrespective of the signal characteristic.

The *ASCII FILE EXPORT* softkey stores the active trace in ASCII format on a floppy disk.

IEC/IEEE command
```
FORM ASC;
MMEM:STOR:TRAC 1,'TRACE.DAT'
```

The file consists of the header containing important scaling parameters and a data section containing the trace data.

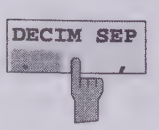
The data of the file header consist of three columns, each separated by a semicolon:
parameter name; numeric value; basic unit

The data section starts with the keyword " Trace <n> " (<n> = number of stored trace), followed by the measured data in one or several columns (depending on measurement) which are also separated by a semicolon.
This format can be read in from spreadsheet calculation programs, eg MS-Excel. It is necessary to define ';' as a separator.

Note: *Different language versions of evaluation programs may require a different handling of the decimal point. It is therefore possible to select between separators '.' (decimal point) and ',' (comma) using softkey DECIM SEP.*

Example:

	Inhalt der Datei	Beschreibung
File header	Type;FSP3;	Instrument model
	Version;1.00;	Firmware version
	Date;01.Jul 1999;	Date of data set storage
	Mode;Spectrum;	Instrument mode
	Center Freq;55000;Hz	Center frequency
	Freq Offset;0;Hz	Frequency offset
	Span;90000;Hz	Frequency range (0 Hz with zero span and statistics measurements)
	x-Axis;LIN;	Scaling of x axis linear (LIN) or logarithmic (LOG)
	Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
	Ref.Level;-30;dBm	Reference level
	Level Offset;0;dB	Level offset
	Ref Position;75;%	Position of reference level referred to diagram limits (0% = lower edge)
	y-Axis;LOG;	Scaling of y axis linear (LIN) or logarithmic (LOG)
	Level Range;100;dB	Display range in in y direction. Unit: dB with x axis LOG, % with x axis LIN
	RF Att;20;dB	Input attenuation
	RBW;100000;Hz	Resolution bandwidth
	VBW;30000;Hz	Video bandwidth
	SWT;0.005;s	Sweep time
	Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
	Detector;SAMPLE;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE, RMS,SAMPLE,QUASIPEAK
	Sweep Count;20;	Number of sweeps set
Data section of the file	Trace 1:;;	Selected trace
	x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
	y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y axis LOG or % with y axis LIN
	Values;501;	Number of test points
	10000;-10.3;-15.7 10180;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2> <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a test point.



The *DECIM SEP* softkey selects the decimal separator between '.' (decimal point) and ',' (comma) with floating-point numerals for the function ASCII FILE EXPORT.
With the selection of the decimal separator different language versions of evaluation programs (eg MS-Excel) can be supported.

IEC/IEEE-bus command `FORM:DEXP:DSEP POIN`

The *COPY TRACE* softkey copies the screen contents of the current trace into another trace memory. The desired memory is selected by entering the number 1, 2 or 3.

Upon copying, the contents of the selected memory is overwritten and the new contents displayed in view mode.

IEC/IEEE-bus command `TRAC:COPY TRACE1,TRACE2`

Selection of Detector

The detectors of FSP are implemented solely with digital techniques. The detectors available are the peak detectors which derive the maximum and/or the minimum value from a number of samples, the rms detector which measures the power within a pixel, the average, the quasipeak and the sample detector. The sample detector routes through the sampled data without any modification or performs a data reduction by suppressing measured values that cannot be displayed.
The peak detectors compare the current level value with the maximum or minimum level from the previously sampled data. When the number of samples defined by the instrument setting is reached, the samples are combined in displayable pixels. Each of the 501 pixels of the display thus represents 1/500 of the sweep range and contains all single measurements (frequency samples) in this subrange in compressed form. For each trace display mode an optimized detector is selected automatically. Since peak detectors and sample detector are connected in parallel, a single sweep is sufficient for collecting all detector values for 3 traces.

Peak detectors
(*MAX PEAK* and *MIN PEAK*)

Peak detectors are implemented by digital comparators. They determine the largest of all positive (max peak) or the smallest of all negative (min peak) peak values of the levels measured at the individual frequencies which are displayed in one of the 501 pixels. This procedure is repeated for each pixel so that for wide frequency spans and despite the limited resolution of the display a large number of measurements can be taken into consideration for the display of the spectrum.

Autopeak detector

The *AUTOPEAK* detector combines the two peak detectors. The max peak detector and the min peak detector simultaneously determine the maximum and the minimum level within a displayed testpoint and display it as a single measured value. The maximum and minimum levels within a frequency point are connected by a vertical line.

Sample detector

The *SAMPLE* detector routes through the sampled data without any further evaluation and either displays them directly or, for reasons of speed in case of short sweep times, first writes them into a memory and processes them subsequently.
There is no data reduction, ie no summing up of measured values of neighbouring frequencies or time samples. If during a frequency sweep more measured values are obtained than can be displayed, measured values will be lost. This means that discrete signals might be lost.
The sample detector therefore can only be recommended for a span-to-resolution bandwidth ratio of up to approx. 250 in order to ensure that no signal will be suppressed (example: span 1 MHz, -> min. bandwidth 5 kHz).

RMS detector

The RMS detector forms the rms value of the measured values within a pixel.
To this effect, FSP uses the linear voltage after envelope detection. The sampled linear values are squared, summed and the sum is divided by the number of samples (= root mean square). For logarithmic display the logarithm is formed from the square sum. For linear display the root mean square value is displayed. Each pixel thus corresponds to the power of the measured values summed up in the pixel.
The rms detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). Correction factors as needed for other detectors for measuring the power of the different signal classes are not required.

Average detector

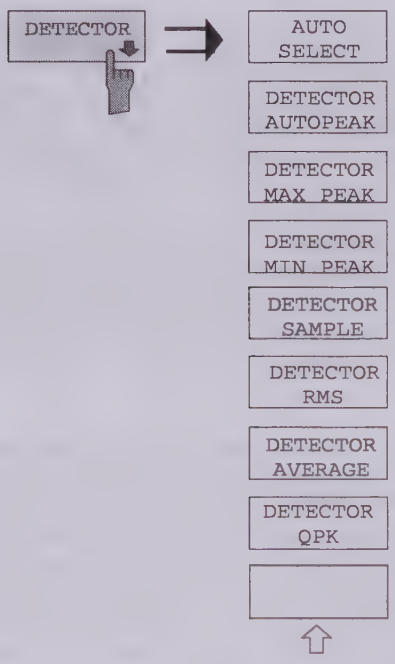
The average detector forms the average value of the measured values within a pixel.
To this effect, FSP uses the linear voltage after envelope detection. The sampled linear values are summed up and the sum is divided by the number of samples (= linear average value). For logarithmic display the logarithm is formed from the average value. For linear display the average value is displayed. Each pixel thus corresponds to the average of the measured values summed up in the pixel.
The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).

Quasipeak detector

The quasipeak detector similates the behaviour of an analog voltmeter by evaluating the measured values in a pixel.
The quasipeak detector is especially designed for the requirements of EMC measurements and is used for evaluating pulse-shaped spurious.

Note: *During a frequency sweep, FSP increments the 1st local oscillator in steps that are smaller than approximately 1/10 of the bandwidth. This is to ensure that the signal level is correctly measured. For narrow bandwidths and wide frequency spans a very large number of measured values is thus obtained. The number of frequency steps, however, always is a multiple of 501 (= number of pixels that can be displayed). With the sample detector selected, only every n^{th} value is displayed. The value of n depends on the number of measured values, ie on the frequency span, the resolution bandwidth and the measurement rate.*

TRACE-DETECTOR submenu



The *DETECTOR* softkey opens a submenu for selecting the detector for the selected trace. The softkey is highlighted if the detector is not selected with *AUTO SELECT*.

The detector can be selected independently for each trace. The *AUTO SELECT* mode selects the optimum detector for each display mode of the trace (Clear/Write, Max Hold or Min Hold).

The softkeys for the detectors are mutually exclusive selection keys.

The *AUTO SELECT* softkey (= default setting) selects the optimum detector for the set display mode of the trace (Clear/Write, Max Hold and Min Hold) and the selected filter mode (bandpass/FFT).

Trace display	**Detector (bandpass)**	**Detector (FFT)**
Clear/Write	Auto Peak	Max Peak
Average	Sample	Sample
Max Hold	Max Peak	Max Peak
Min Hold	Min Peak	Max Peak

The detector activated for the specific trace is identified in the respective trace display field as follows:

Detector	
Auto Peak	AP
Max Peak	PK
Min Peak	MI
Average	AV
RMS	RM
Sample	SA
Quasipeak	QP

IEC/IEEE-bus command `DET:AUTO ON`

The *DETECTOR AUTOPEAK* softkey activates the autopeak detector.

IEC/IEEE-bus command `DET APE`

The *DETECTOR MAX PEAK softkey* activates the max peak detector. It is recommended for measurement of impulsive signals.

IEC/IEEE-bus command `DET POS`

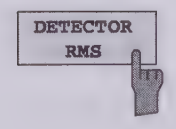
The *DETECTOR MIN PEAK* softkey activates the min peak detector. Weak sinewave signals become clearly visible in noise using this detector. In case of a composite signal made up of sinewave and impulsive signals, the impulsive signals are suppressed.

IEC/IEEE-bus command `DET NEG`

The *DETECTOR SAMPLE* softkey activates the sample detector.

It is used for measuring uncorrelated signals such as noise. The power can be determined with the aid of fixed correction factors for evaluation and the logarithmic function.

IEC/IEEE-bus command `DET SAMP`



The *DETECTOR RMS* softkey activates the rms detector.

The rms detector supplies the power of the signal independent of the waveform. To this effect the root mean square of all sampled level values is formed during the sweep of a pixel. The sweep time thus determines the number of averaged values and with increasing sweep time better averaging is obtained. The rms detector is thus an alternative for averaging over several sweeps (see TRACE AVERAGE).

Since the video bandwidth must be at least 10 times the resolution bandwidth (RBW) to ensure that video filtering does not invalidate the rms values of the signal, this ratio is set automatically upon activating the detector.

IEC/IEEE-bus command `DET RMS`

The *DETECTOR AVERAGE* softkey activates the average detector.

In contrast to the rms detector, the average detector supplies the linear average of all sampled level values during the sweep of a pixel.
The same relations as for the rms detector apply (see above).

IEC/IEEE-bus command `DET AVER`

The *DETECTOR QPK* softkey activates the quasipeak detector.

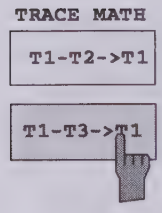
This detector evaluates the sampled level values during the sweep of a pixel like an analog voltmeter.
On switching the quasipeak detector on the video bandwidth is automatically set to 10 MHz so as to exclude the influence of the video filter on the signal evaluation.

IEC/IEEE-bus command `DET QPE`

Mathematical Functions for Traces

TRACE 1-TRACE MATH submenu:

The *TRACE MATH* softkey opens a submenu in which the difference between the selected trace to trace 1 is calculated. The softkey is highlighted if a math function is activated.



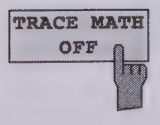
The *T1-T2* and *T1-T3* softkeys subtract the corresponding traces. The result displayed is referred to the zero point defined by *TRACE POSITION*.

To indicate that the trace has been obtained by subtraction, the difference "1 - 2" or "1 - 3" is indicated on the trace info of trace 1 and in the *TRACE* main menu the *TRACE MATH* softkey is highlighted.

IEC/IEEE-bus command `CALC:MATH (TRACE1-TRACE2)`
`CALC:MATH (TRACE1-TRACE3)`

The *TRACE POSITION* softkey activates the entry of the trace position for 0 difference. The position is stated in % of the diagram height.
The range of values extends from -100% to +200%

IEC/IEEE-bus command `DISP:MATH:POS 50PCT`



The *TRACE MATH OFF* softkey switches the math function off.

IEC/IEEE-bus command `CALC:MATH:STAT OFF`

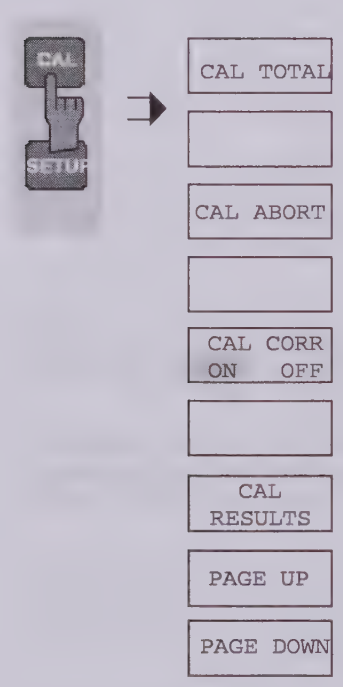
Recording the Correction Data of FSP – *CAL* Key

FSP maintains its high measurement accuracy through the integrated sytem error correction method.

The correction and characteristic data required for the correction are determined by comparison of the results at different settings with the known characteristics of the high-precision calibration signal source of FSP at 128 MHz. The correction data are then available in the instrument as a file and can be displayed by means of the *CAL RESULTS* softkey.
For servicing the consideration of correction data can be deactivated by means of the *CAL CORR ON/OFF* softkey. If the correction data recording is aborted, the last complete correction data set is restored.

Note: *The term "Calibration" formerly used for the integrated system error correction was often mistaken for the "true" calibration of the instrument at the test set in production and in service. It is therefore no longer used although it appears in the abbreviated form in the name of keys ("CAL...").*

CAL menu:



The *CAL* key opens a menu with the available functions for recording, displaying and activating the data for system error correction.

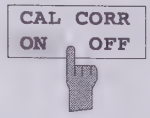
The *CAL TOTAL* softkey starts the recording of correction data of the instrument.

If the correction data recording has failed or if the correction values are deactivated (*CAL CORR = OFF* softkey), the status field indicates UNCAL.

IEC/IEEE-bus command: `*CAL?`

The *CAL ABORT* softkey interrupts the recording of correction data and restores the last complete correction data set.

IEC/IEEE-bus command: `CAL:ABOR`



The *CAL CORR ON/OFF* softkey switches the calibration data on/off.

ON The status message depends upon the results of the total calibration.

OFF The message *UNCAL* appears in the status line.

IEC/IEEE-bus command: `CAL:STAT ON`

The *CAL RESULTS* softkey calls the *CALIBRATION RESULTS* table, which shows the correction data found during calibration.

The *CALIBRATION RESULTS* table contains the following information:

- date and time of last record of correction valuesKorrekturwertaufnahme
- overall results of correction value record
- list of found correction values according to function/module

The results have the following meaning:

PASSED calibration successful without any restrictions

CHECK deviation of correction value larger than expected, correction could however be performed

FAILED deviations of correction value too large, no correction was possible. The found correction data are not valid.

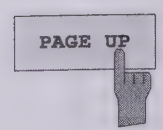
ABORTED calibration aborted

CALIBRATION RESULTS

```
Calibration: PASSED
Date:        05.Jun 1999 16:24:54

Total GAIN Adjust                PASSED
Calibration of IF Filters        PASSED
Bandwidth:
Filter   Cal Val [Hz]  DAC Val  State
100kHz    1.804e+03      3698   PASSED
300kHz    8.417e+03      3516   PASSED
  1MHz    2.806e+04      2881   PASSED
  3MHz    1.804e+03      3698   PASSED
 10MHz    8.417e+03      3516   PASSED
```

IEC/IEEE-bus command: `CAL:RES?`

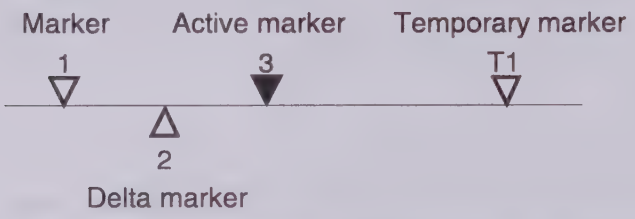


The softkeys *PAGE UP* and *PAGE DOWN* scroll one page forward or backward in the *CALIBRATION RESULTS* table. They have no function when the table is closed.

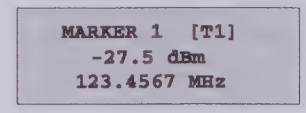
IEC/IEEE-bus command: `--`

Markers and Delta Markers – *MKR* Key

The markers are used for marking points on traces, reading out measurement results and for quickly selecting a display section. FSP provides four markers per display window. All markers can be used either as markers or delta markers. The availability of marker functions depends on whether the measurement is performed in the frequency, time or level domain.
The marker that can be moved by the user is defined in the following as the **active marker**.
Examples of marker display:

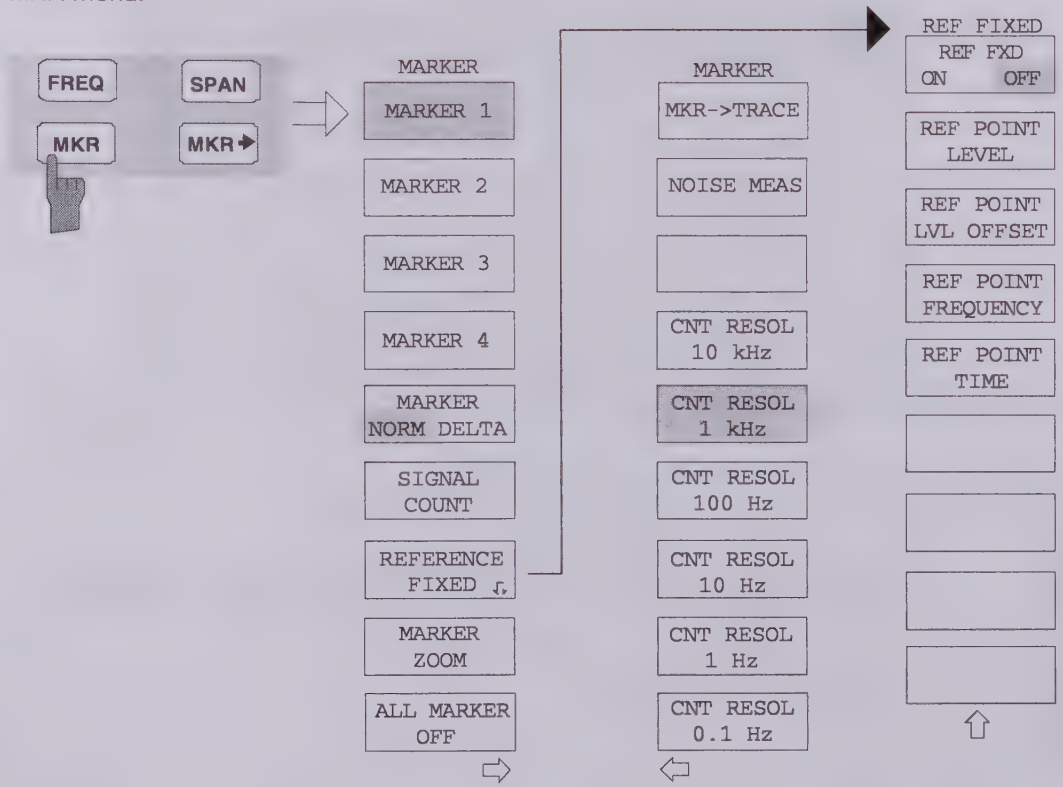


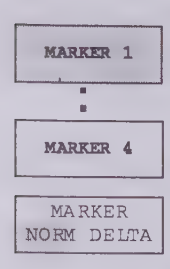
Temporary markers are used in addition to the markers and delta markers to evaluate the measurement results. They disappear when the associated function is deactivated.
The measurement results of the active marker (also called **marker values**) are displayed in the marker field. The marker info field at the upper right of the display shows the marker location (here, frequency), the level and the currently selected trace [T1].



The *MKR* key calls a menu that contains all marker and delta marker standard functions. If no marker is active, *MARKER 1* will be enabled and a peak search on the trace carried out. Otherwise, the data entry for the marker activated last is opened.

MKR menu:





The *MARKER 1/2/3/4* .softkey selects the corresponding marker and activates it.

MARKER 1 is always the normal marker. After they have been switched on, *MARKERS 2 to 4* are delta markers that refer to *MARKER 1*. These markers can be converted into markers with absolute value display by means of the *MARKER NORM DELTA* softkey. When *MARKER 1* is the active marker, pressing the M*ARKER NORM DELTA* softkey switches on an additional delta marker.

Pressing the *MARKER 1 to 4* softkey again switches off the selected marker.

Example:

[**PRESET**] FSP is set to the default setting.

[**MKR**] On calling the menu, *MARKER 1* is switched on ('1' highlighted in the softkey) and positioned on the maximum value of the trace. It is a normal marker and the *MARKER NORMAL* softkey is highlighted.

[*MARKER 2*] *MARKER 2* is switched on ('2' highlighted in the softkey). It is automatically defined as a delta marker on switching on so the *DELTA* is is highlighted on softkey *MARKER NORM DELTA*. The frequency and level of *MARKER 2* with reference to *MARKER 1* are output in the marker info field.

[MARKER NORM DELTA] The *MARKER NORM DELTA* softkey is highlighted. *MARKER 2* becomes a normal marker. The frequency and level of *MARKER 2* are output as absolute values in the marker info field.

[MARKER 2] *MARKER 2* is switched off. *MARKER 1* is the active marker for entry. The frequency and level of *MARKER 1* are output in the marker info field.

IEC/IEEE-bus command:

```
CALC:MARK ON;
CALC:MARK:X <value>;
CALC:MARK:Y?

CALC:DELT ON;
CALC:DELT:MODE ABS|REL
CALC:DELT:X <value>;
CALC:DELT:X:REL?
CALC:DELT:Y?
```

When several traces are being displayed, the marker is set to the maximum value (peak) of the active trace which has the lowest number (1 to 3). In case a marker is already located there, it will be set to the frequency of the next lowest level (next peak).

When the split-screen display mode is active, the marker will be placed in the active window. A marker can only be enabled when at least one trace in the corresponding window is visible.

If a trace is turned off, the corresponding markers and marker functions are also deactivated. If the trace is switched on again (*VIEW, CLR/WRITE*;..), the markers along with coupled functions will be restored to their original positions provided the markers have not been used on another trace.

The *MKR→TRACE* softkey places the marker on a new trace. The trace is selected via a data entry field. Only those traces can be selected which are visible on the screen in the same window.

Example:
Three traces are presented on the screen. The marker is always on Trace 1 on switching on.

[MKR ->TRACE]
"2"<ENTER> The marker jumps to Trace 2 but remains on the previous frequency or time.

[MKR ->TRACE]
"3"<ENTER> The marker jumps to Trace 3. '

IEC/IEEE-bus command:
```
CALC:MARK1:TRAC 1
CALC:DELT:TRAC 1
```

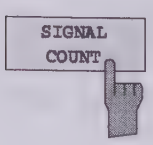
Frequency Measurement with the Frequency Counter

In order to accurately determine the frequency of a signal, FSP is equipped with a frequency counter which measures the frequency of the RF signal at the intermediate frequency. Using the measured IF, FSP calculates the frequency of the RF input signal by applying the known frequency conversion factors.

The frequency measurement error depends only upon the accuracy of the frequency standard used (external or internal reference). Although FSP always operates synchronously irrespective of the set span, the frequency counter delivers a more exact result than a measurement performed with a marker. This is due to the following:

- The marker measures only the position of the pixel on the trace and infers the frequency of the signal from this value. The trace, however, contains only a limited number of pixels. Depending upon the selected span, each pixel may contain many measurement values, which therefore limits the frequency resolution.
- The resolution with which the frequency can be measured is proportional to the measurement time. For this reason, the bandwidth is normally made as wide as possible and the sweep time as short as possible. This results in a loss of frequency resolution.

For the measurement with the frequency counter, the sweep is stopped at the reference marker, the frequency is counted with the desired resolution and then the sweep is allowed to continue.

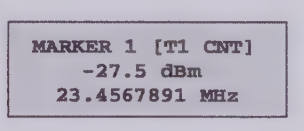


The *SIGNAL COUNT* softkey switches the frequency counter on/off.

The frequency is counted at the position of the reference marker (*MARKER* 1). The sweep stops at the reference marker until the frequency counter has delivered a result. The time required for a frequency measurement depends on the selected frequency resolution. The resolution is set in the side menu.

If no marker is enabled when the *SIGNAL COUNT* softkey is pressed, *MARKER 1* is switched on and set at the largest signal.

In addition, the *SIGNAL COUNT* function is displayed in the marker info field on the screen with [Tx CNT].

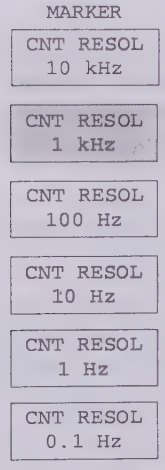


Switching the *SIGNAL COUNT* function off is accomplished by pressing the softkey again.

IEC/IEEE-bus command:
```
CALC:MARK1:COUN ON;
CALC:MARK:COUN:FREQ?
```

MARKER NEXT menu

The resolution of the frequency counter is set in the *NEXT* menu of the MARKER menu. FSP offers counter resolutions between 0.1 Hz and 10 kHz.



The *CNT RESOL ...* softkeys select the counter resolution. They are selection switches, i.e. only one of the can be active at any one time.
The marker stop time, ie the frequency measurement time, depends on the selected resolution.

IEC/IEEE-bus command:
```
CALC:MARK1:COUN:RES <value>
```

Measurement example:
The frequency of a CW signal is to be determined by means of the frequency counter with a resolution of 10 Hz.

[**PRESET**] FSP is set to the default setting.

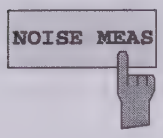
[**MARKER**] *MARKER 1* is switched on and set to the maximum value of the displayed spectrum.

[*SIGNAL COUNT*] The frequency counter is switched on. FSP counts the frequency of the signal at the marker position with a resolution of 1 kHz. The counted frequency is indicated in the marker info field.

[*NEXT*] Changes to the submenu for setting the counter resolution.

[*CNT RESOL 10 Hz*] The frequency counter resolution is increased to 10 Hz.

Noise Power Density Measurement



The *NOISE MEAS* softkey switches the noise measurement for the active marker on/off. The active marker becomes the *NORMAL* marker.

During a noise measurement, the noise power density is measured at the position of the marker. In the time domain display, all points of the trace are used to determine the noise power density. In the frequency domain, two points on the right and on the left of the marker are used to obtain a more stable result.
The noise power density is displayed in the marker field. With a logarithmic level axis, the noise power density is output in dBm/Hz, dBµV/Hz or dBµA/Hz, ie as a level in 1 Hz bandwidth over 1 mW, 1 µV or 1 µA. With a linear level axis, the noise voltage density is determined in µV/√Hz, the noise current density in µA/√Hz or the noise power density in µW/Hz.

The following additional settings should be performed to obtain correct noise power density measurement:

Detector: sample or RMS

Video bandwidth: ≤ 0.1 x resolution bandwidth (RBW) with sample detector (corresponds to RBW / VBW NOISE)
≥ 3 x resolution bandwidth (RBW) with RMS detector (corresponds to RBW / VBW SINE)

In the default setting, FSP uses the sample detector after calling the noise function.

With the sample detector the trace can also be set to AVERAGE to stabilize the measurement values. When the RMS detector is operated, trace averaging should not be used, since it delivers too low noise levels which cannot be corrected. Instead, the sweep time can be increased to obtain stable measurement results.

FSP uses the following correction factors to determine the noise power density from the marker level:

- Since the noise power referred to a bandwidth of 1 Hz is displayed, the bandwidth correction value is deducted from the marker level. This value is 10 x lg (1 Hz/BW_{noise}), BW_{noise} being the noise or power bandwidth of the selected resolution filter (RBW).

Sample detector:

- Due to the averaging by the video filter and possibly by trace averaging, 1.05 dB is added to the marker level. This is the difference between the average value and the rms value of white noise.
- With a logarithmic level axis, 1.45 dB is added on top of that. Thus, logarithmic averaging is taken into account since it produces a value which is 1.45 dB lower than that of linear averaging.

RMS detector:

- Except the bandwidth correction, no further correction values are required with the RMS detector since it displays the power for each pixel of the trace.

In order to produce a stable noise display, neighbouring points (symmetrical about the measurement frequency) on the trace are averaged.

In the time domain display, averaging of the results takes place in time (after each sweep).

IEC/IEEE-bus command:
```
CALC:MARK1:FUNC:NOIS ON;
CALC:MARK1:FUNC:NOIS:RES?
```

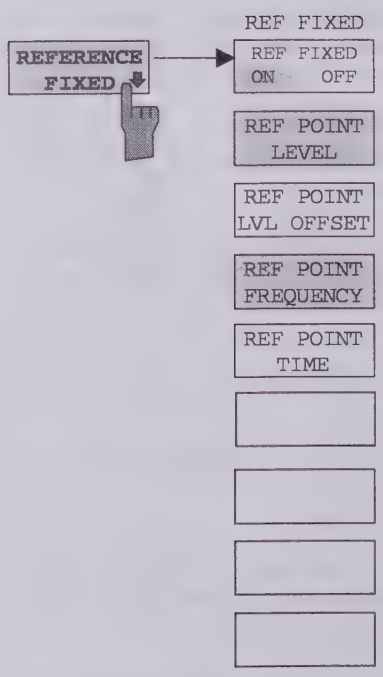
Example: Measurement of FSP inherent noise

[**PRESET**] FSP is set to the default setting.

[**MARKER**] *MARKER 1* is switched on and set to the maximum value of the displayed spectrum. Set the marker to the required frequency by means of the rollkey.

[*NOISE*] FSP switches on the sample detector and sets the video bandwidth to 300 kHz (0.1 x RBW). The power density level of the inherent noise is displayed in dBm/Hz in the marker info field.

Note: *The FSP noise figure can be calculated from the measured power density level. In addition, the RF attenuation (RF Att) is to be deducted from the displayed noise level. Add 174 to the result to obtain the FSP noise figure.*

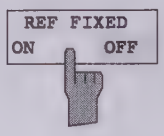


The *REFERENCE FIXED* softkey defines the level and the frequency or time of *MARKER 1* as a reference for one or several delta markers. The measured values for one or several markers displayed in the marker info field are derived from this reference point instead of the current values of the reference marker (*MARKER* 1).

On actuating the softkey, reference fixed is switched on and thus, the level value and the frequency, time or x-level value of *MARKER 1* immediately become the reference point.

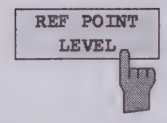
Additionally, the *REFERENCE FIXED* softkey opens the submenu where it is possible to determine manually a reference point with level and frequency, time or x-axis level, to define a level offset or deactivate the reference point.

The *REFERENCE FIXED* function is useful for the measurement of the harmonic suppression at small span (fundamental not represented).



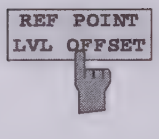
The *REF FXD ON/OFF* softkey switches on or off the relative measurement to a fixed reference value (*REFERENCE POINT*) independent of the trace.

IEC/IEEE-bus command: `CALC:DELT2:FUNC:FIX ON`



The *REF POINT LEVEL* softkey enters a reference level independent of the reference marker level. All relative level values of the delta markers refer to this reference level.

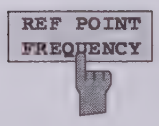
IEC/IEEE-bus command:
`CALC:DELT2:FUNC:FIX:RPO:Y -10dBm`



The *REF POINT LVL OFFSET* softkey specifies a level offset relevant to the reference level. The relative level values of the delta markers refer to the reference point level plus the level offset.

The level offset is set to 0 dB on enabling the *REFERENCE FIXED* or *PHASE NOISE* function.

IEC/IEEE-bus command:
`CALC:DELT2:FUNC:FIX:RPO:Y:OFFS 0dB`



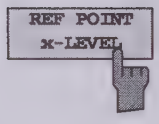
With the *REF POINT FREQUENCY* softkey a reference frequency can be manually activated for the delta markers when the *REFERENCE FIXED* or *PHASE NOISE* function is used.

IEC/IEEE-bus command:
`CALC:DELT2:FUNC:FIX:RPO:X 10.7MHz`

The *REF POINT TIME* softkey activates the entry box for the input of a reference time for the *REFERENCE FIXED* function in the time domain (span = 0 Hz).

IEC/IEEE-bus command:
`CALC:DELT2:FUNC:FIX:RPO:X 5MS`

For phase noise measurement, input of reference time is not possible.



The *REF POINT x-LEVEL* softkey activates the entry box for the input of a reference level on the x-axis for the *REFERENCE FIXED* function when the power sweep is active.

IEC/IEEE-bus command:
`CALC:DELT2:FUNC:FIX:RPO:X -5DBM`

Measurement example:
Small-span harmonics measurement to increase sensitivity
CW signal (eg 100 MHz, 0 dBm) with harmonics at the RF input of FSP.

[**PRESET**]	FSP is set to the default setting.
[**CENTER**: 100 **MHz**]	The center frequency of FSP is set to 100 MHz.
[**SPAN**: 1 **MHz**]	The span is set to 1 MHz.
[**AMPL**: 3 **dBm**]	The reference level is set to 3 dBm (3 dB above the expected RF level).
[**MKR**]	*MARKER* 1 is switched on ('1' highlighted in the softkey) and set to the signal peak.
[*MARKER 2*]	*MARKER 2* is switched on and automatically defined as the delta marker (*DELTA* is highlighted on *MARKER NORM DELTA* softkey).
[*REFERENCE FIXED*]	The frequency and level of *MARKER 1* are a reference for the delta marker.
[**CENTER**: 200 **MHz**]	The center frequency is set to 200 MHz (= frequency of the 2nd harmonic). The reference level may have to be reduced to see the 2nd harmonic from the noise. This does not affect the reference level set with *REFERENCE FIXED*.
[**MKR->**: *PEAK*]	The delta marker jumps to the 2nd harmonic of the signal. The level spacing of the harmonic to the fundamental is displayed in the marker info field.

The *MARKER ZOOM* softkey expands the area around MARKER 1. With the zoom function, more details of the spectrum can be seen. The desired display range can be defined in an entry window.
The following sweep is stopped at the position of the reference marker. The frequency of the signal is counted and the measured frequency becomes the new center frequency. The zoomed display range is then configured and the new settings are used by FSP for further measurements.

As long as switching to the new frequency display range has not yet taken place, pressing the softkey will abort the procedure.

If *MARKER 1* is not active when the softkey is pressed, it is automatically activated and set to the highest peak in the window.

If an instrument setting is changed after selection of *MARKER ZOOM*, the function is aborted.

The *MARKER ZOOM* softkey is only available in the frequency domain (span > 0).

IEC/IEEE-bus command: `CALC:MARK1:FUNC:ZOOM 1kHz`

The *ALL MARKER OFF* softkey switches off all markers (reference and delta markers). It also switches off all functions and displays associated with the markers/delta markers.

IEC/IEEE-bus command: `CALC:MARK:AOFF`

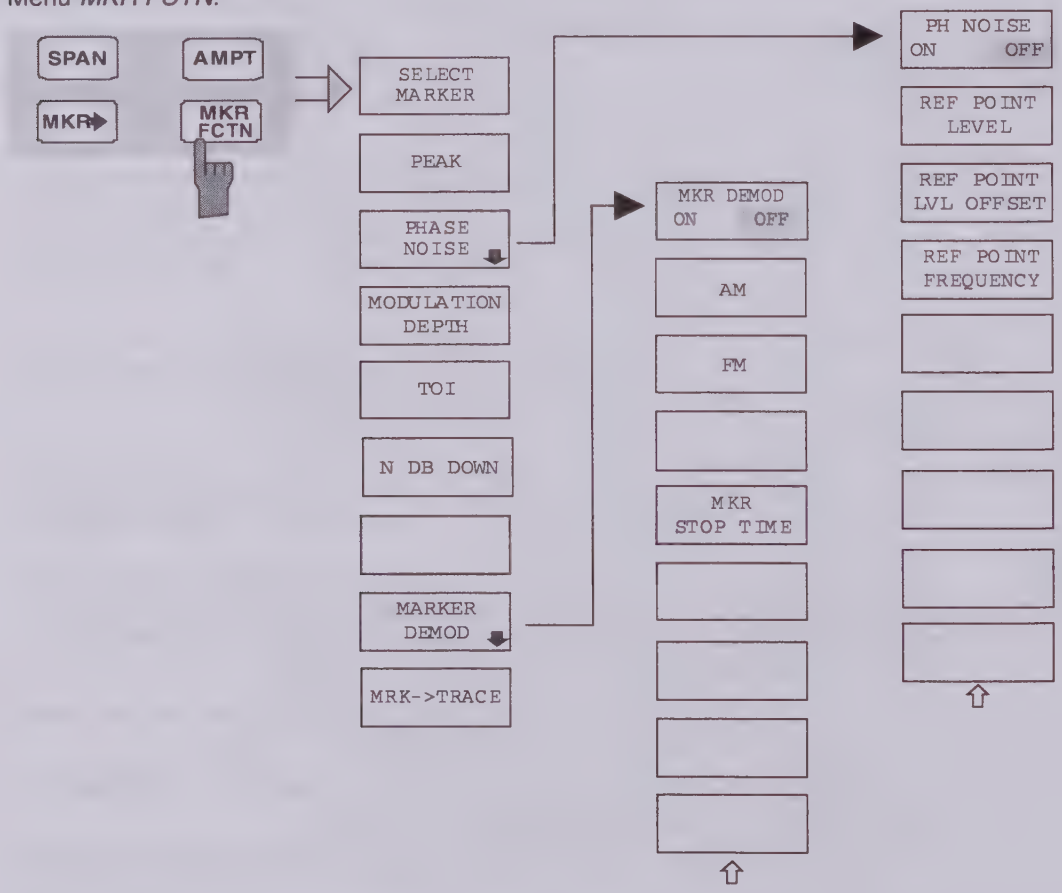
Marker Functions – *MKR FCTN* Key

The MKR FCTN menu offers further measurements with the markers:

- Measurement of phase noise (*PHASE NOISE* softkey)
- Measurement of AM modulation depth (*MODULATION DEPTH* softkey)
- Measurement of the third order intercept (*TOI* softkey)
- Measurement of filter or signal bandwidth (*N DB DOWN* softkey)
- Activating of AF demodulation (*MARKER DEMOD* softkey)

On calling the menu, the entry for the last active marker is activated (*SELECT MARKER* softkey); if no marker is activated, marker 1 is activated and a maximum search (*PEAK* softkey) is performed. The marker can be set to the desired trace by means of *MKR -> TRACE* softkey.

Menu *MKR FCTN*:

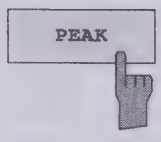


Activating the Markers

Menu *MKR FCTN*:

The *SELECT MARKER* softkey activates the numerical selection of the marker in the data entry field. Delta marker 1 is selected by input of ' 0 '.
If the marker is switched off, then it is switched on and can be shifted afterwards.

IEC/IEEE-bus command:
```
CALC:MARK1 ON;
CALC:MARK1:X <value>;
CALC:MARK1:Y?
```

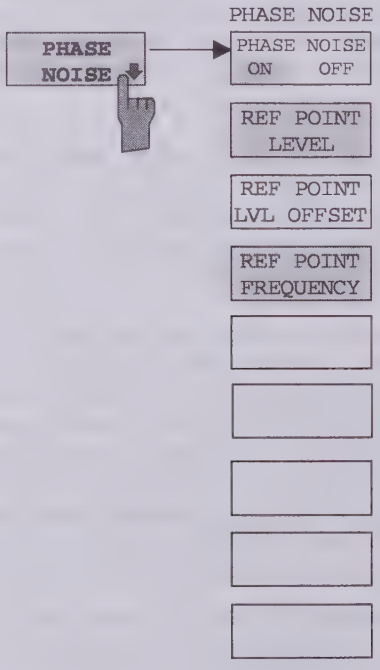


The *PEAK* softkey sets the active marker/delta markerto the peak of the trace.

IEC/IEEE-bus command:
```
CALC:MARK1:MAX
CALC:DELT1:MAX
```

Phase Noise Measurement

Menu MKR FCTN:



The *PHASE NOISE* softkey switches the *PHASE NOISE* function on/off. Additionally, the softkey opens the submenu for manually setting the reference point. The phase noise measurement can be switched off in the submenu.

MARKER 1 (= reference marker) is used as a reference for the phase noise measurement. The frequency and level of the reference marker are used as fixed reference values, ie the *REFERENCE FIXED* function is activated. After switching on the phase noise measurement the reference level or the center frequency can thus be set such that the carrier is outside the displayed frequency range, or, for example, a notch filter is switched on to suppress the carrier.
A noise power density measurement is carried out with the delta marker or delta markers. This measurement corresponds to the NOISE function in the *MARKER* menu (MKR). The result of the phase noise measurement is the difference in level between the reference point and the noise power density.

The following possibilities can be selected on switching on *PHASE NOISE*:

1. No marker enabled:

[**MKR FCTN**] *MARKER 1* is enabled and set to peak.

[*PHASE NOISE*] *MARKER 1* becomes the reference marker, *MARKER 2* the delta marker; frequency = frequency of the reference marker. The delta marker is the active marker, ie it can be moved with the rollkey or adjusted by entering numerals. The *PHASE NOISE* function is switched on and the measured value is output.

2. Markers are enabled:

[**MKR FCTN**] The previous marker configuration remains unchanged.

[*PHASE NOISE*] *MARKER* 1 becomes the reference marker. If other markers are enabled, they become delta markers and measure the phase noise at their respective positions.

If further markers are enabled during the phase noise measurement, they automatically become delta markers and measure the phase noise at their respective positions.

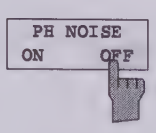
When the phase noise measurement is switched off, the marker configuration remains unchanged and the delta markers measure the relative level to the reference marker (*MARKER 1*).

The *PHASE NOISE* function measures the noise power at the delta markers referred to 1 Hz bandwidth. The sample detector is automatically used and the video bandwidth set to 0.1 times the resolution bandwidth (RBW). The two settings are taken into account in the correction values used for the noise power measurement.
To obtain stable results, two pixels on the right and the left of the respective delta marker position are taken for the measurement. The procedure for determining the noise power is identical to the method used for the noise power measurement (see NOISE softkey). The measured noise level referred to 1 Hz bandwidth is deducted from the carrier level at the reference marker (*MARKER 1*). The measured values are displayed in the delta marker field in dBc/Hz (= spacing in dB of the noise power from the carrier level in 1 Hz bandwidth).

If several delta markers are enabled, only the value read by the active marker is shown in the marker field. If several delta markers are active, their measurement results are shown in the marker info field.

The reference value for the phase noise measurement can be defined with *REF POINT LEVEL*, *REF POINT FREQUENCY* and *REF POINT LVL OFFSET* to differ from that of the reference marker.

IEC/IEEE-bus command: --

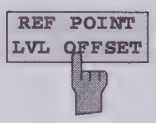


The *PH NOISE ON/OFF* softkey switches on/off the phase noise measurement. Switching on is performed by means of the *PHASE NOISE* softkey and is only necessary when the phase noise measurement has been switched off in the submenu.

IEC/IEEE-bus command:
```
CALC:DELT1:FUNC:PNO ON
CALC:DELT1:FUNC:PNO:RES?
```

The *REF POINT LEVEL* softkey activates an entry box for the input of a reference level other than the reference marker level. The function is identical to that of the softkey with the same name in the marker menu (MKR).

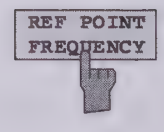
IEC/IEEE-bus command:
```
CALC:DELT1:FUNC:FIX:RPO:Y -10dB
```



The *REF POINT LVL OFFSET* softkey activates an entry box for the input of an additional level offset for the phase noise calculation.

This level offset is set to 0 dB on when the *REFERENCE FIXED* or *PHASE NOISE* function is enabled.

IEC/IEEE-bus command:
```
CALC:DELT:FUNC:FIX:RPO:Y:OFFS 10dB
```



The *REF POINT FREQUENCY* softkey activates an entry box for the manual input of a reference frequency for the *REFERENCE FIXED* or *PHASE NOISE* function.

IEC/IEEE-bus command:
```
CALC:DELT1:FUNC:FIX:RPO:X 10.7MHz
```

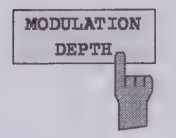
Measurement example:

The phase noise of a CW signal at 100 MHz with 0 dBm level is to be measured at 800 kHz from the carrier

[**PRESET**]	FSP is set to the default setting.
[**CENTER**: 100 **MHz**]	The center frequency is set to 100 MHz.
[**SPAN**: 2 **MHz**]	The span is set to 2 MHz.
[**AMPT**: 0 **dBm**]	The reference level is set to 0 dBm.
[**MKR FCTN**]	*MARKER 1* is switched on and positioned at the maximum of the displayed trace.
[*PHASE NOISE*: 800 **kHz**]	The phase noise measurement is switched on. The delta marker is positioned on the main marker and the measured phase noise value is displayed in the marker info field. The sample detector is used and the video bandwidth is set to 0.1 x RBW. When the phase noise measurement function is enabled, the entry of the delta marker frequency is activated. It can be entered directly.

Measurement of the AM Modulation Depth

Menu *MKR FCTN*:



The *MODULATION DEPTH* softkey switches on the measurement of the AM modulation depth. An AM-modulated carrier is required on the screen for ensuring correct operation.
The level value of *MARKER 1* is taken as the carrier level. When this function is enabled, *MARKER 2* and *MARKER 3* are automatically set symmetrically about the carrier to the adjacent peak values of the trace as delta markers and *MARKER 2* is activated for the entry.
When the position of *MARKER 2* (delta) is changed, *MARKER 3* (delta) is moved symmetrically with respect to the reference marker (*MARKER 1*).
If the data entry is activated for *MARKER 3* (*MARKER 1 2 3 4* softkey), the latter can be moved for fine adjustment irrespective of *MARKER 2*.

FSP calculates the power at the marker positions from the measured levels. The AM modulation depth is calculated from the ratio between the power values at the reference marker and at the delta markers. When the powers of the two AM side bands are unequal, the mean value of the two power values is used for AM modulation depth calculation.

Measurement example:

The AM modulation depth of a carrier modulated with 1 kHz is to be measured at 100 MHz.

[**PRESET**]	FSP is set to the default setting.
[**CENTER**: 100 **MHz**]	The center frequency is set to 100 MHz.
[**SPAN**: 5 **kHz**]	The span is set to 5 kHz.
[**AMPT**: 0 **dBm**]	The reference level is set to 0 dBm.
[**MKR FCTN**]	*MARKER 1* is switched on and positioned at the maximum of the displayed trace.
[*MODULATION DEPTH*: 1 **kHz**]	The measurement of the AM modulation depth is switched on. *MARKERS 2* and *3* (delta markers) are set to the adjacent peak values of the trace and are activated for the frequency entry. The AM modulation depth is output in % in the marker info field. When 1 kHz is entered, *MARKER 2* can be exactly positioned on 1 kHz and *MARKER 3* at -1 kHz from the reference marker.

IEC/IEEE-bus command:

```
CALC:MARK:FUNC:MDEP ON;
CALC:MARK:FUNC:MDEP:RES?
```

Measurement of the Third Order Intercept (TOI)

If several signals are applied to a transmission twoport with nonlinear characteristic, intermodulation products appear at its output by the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals which intermodulate at the characteristic. The intermodulation products of lower order have a special effect since their level is largest and they are near the useful signals. The intermodulation product of third order causes the highest interference. It is the intermodulation product generated from one of the useful signals and the 2nd harmonic of the second useful signal in case of two-tone modulation.
The frequencies of the intermodulation products are above and below the useful signals. Fig. 4-5 shows intermodulation products P_{I1} and P_{I2} generated by the two useful signals P_{U1} and P_{U2}.

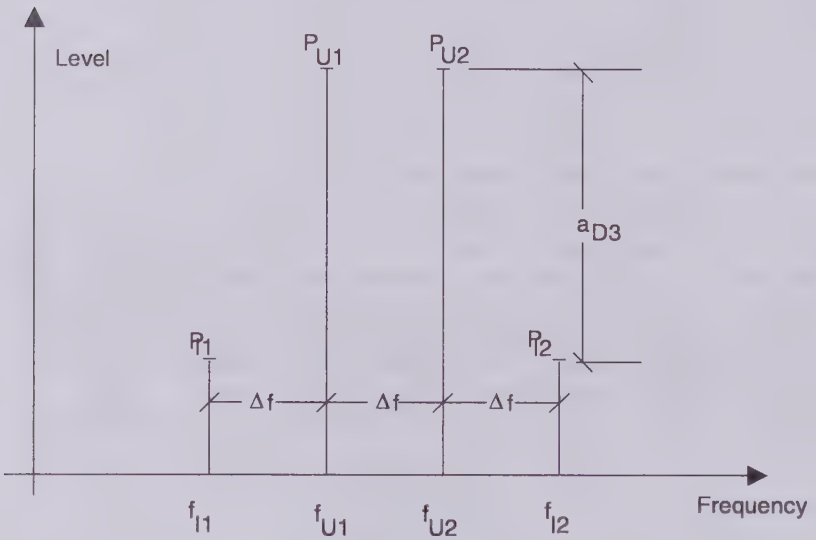


Fig. 4-5 Intermodulation products P_{U1} and P_{U2}

The intermodulation product at f_{I2} is generated by mixing the 2nd harmonic of useful signal P_{U2} and signal P_{U1}, the intermodulation product at f_{I1} by mixing the 2nd harmonic of useful signal P_{U1} and signal P_{U2}.

$f_{i1} = 2 \times f_{u1} - f_{u2}$ (1)

$f_{i2} = 2 \times f_{u2} - f_{u1}$ (2)

The level of the intermodulation products depends on the level of the useful signals. If the two useful signals are increased by 1 dB, the level of the intermodulation products increases by 3 dB, which means that spacing a_{D3} between intermodulation signals and useful signals is reduced by 2 dB. This is illustrated in Fig. 4-6.

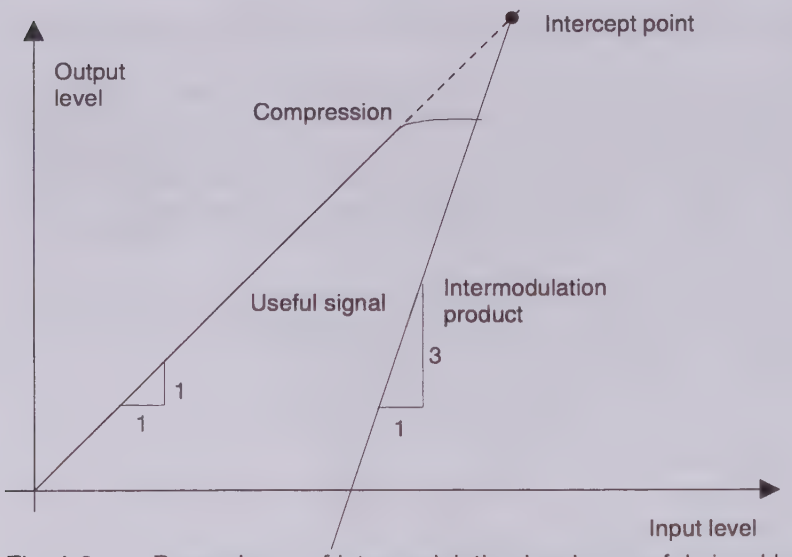


Fig. 4-6 Dependence of intermodulation level on useful signal level

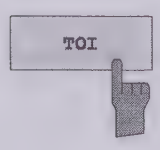
The useful signals at the twoport output increase proportionally with the input level as long as the twoport is in the linear range. A level change of 1 dB at the input causes a level change of 1 dB at the output. As from a certain input level, the twoport goes into compression and the output level stops increasing. The intermodulation products of the third order increase three times as much as the useful signals. The intercept point is the fictitious level where the two lines intersect. It cannot be measured directly since the useful level is previously limited by the maximum twoport output power.
It can be calculated from the known line slopes and the measured spacing a_{D3} at a given level according to the following formula.

$$IP3 = \frac{a_{D3}}{2} + P_N \qquad (3)$$

The third order intercept IP3, for example, is calculated for an intermodulation of 60 dB and an input level P_U of -20 dBm according to the following formula:

$$IP3 = \frac{60}{2} + (-20dBm) = 10dBm. \qquad (4)$$

Menu *MKR FCTN*:



The *TOI* softkey enables the measurement of the third order intercept.
A two-tone signal with equal carrier levels is expected at the FSP input. *MARKER 1* and *MARKER 2* (both normal markers) are set to the maximum of the two signals. *MARKER 3* and *MARKER 4* (both delta markers) are placed on the intermodulation products. When the function is enabled, the frequency entry is activated for the delta markers. They can be set manually. FSP calculates the third order intercept from the level spacing between normal markers and delta markers and outputs it in the marker info field.

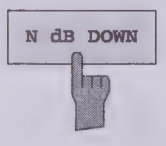
IEC/IEEE-bus command:
```
CALC:MARK:FUNC:TOI ON;
CALC:MARK:FUNC:TOI:RES?
```

Example:
A two-tone signal with frequencies of 100 MHz and 101 MHz is applied to the RF input of FSP. The level of the two signals is -10 dBm.

[**PRESET**]	FSP is set to the default setting.
[**CENTER**: 100.5 **MHz**]	The center frequency is set to 100.5 MHz.
[**SPAN**: 3 **MHz**]	The span is set to 3 MHz.
[**AMPT**: -10 **dBm**]	The reference level is set to -10 dBm.
[*MKR FCTN*]	*MARKER 1* is switched on and set to the signal peak.
[*TOI*]	FSP sets the 4 markers to the useful signals and the intermodulation products and calculates the third order intercept. The result is output in the marker info field.

Measurement of the Filter or Signal Bandwidth

Menu *MKR FCTN*:



The *N dB DOWN* softkey activates the temporary markers T1 and T2 which are n dB below the active reference marker. Marker T1 is at the left and marker T2 at the right of the reference marker. The value n can be input in a window.

The default setting is 3 dB.

The frequency spacing of the two temporary markers is indicated in the marker info field.
If, for example, it is not possible to form the frequency spacing for the n dB value because of the noise display, dashes are indicated instead of a measured value.

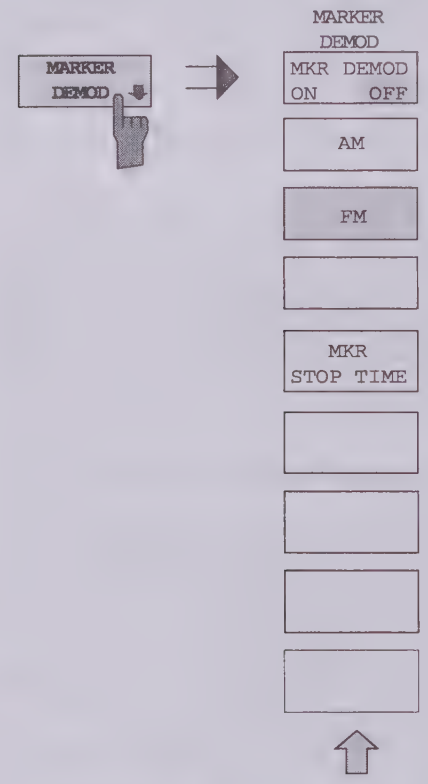
IEC/IEEE-bus command:

```
CALC:MARK1:FUNC:NDBD:STAT ON
CALC:MARK1:FUNC:NDBD 3dB
CALC:MARK1:FUNC:NDBD:RES?
CALC:MARK1:FUNC:NDBD:FREQ?
```

AF Demodulation

FSP provides demodulators for AM and FM signals when equipped with Option AF-Demodulator (FSP-B3). With these demodulators, a displayed signal can be identified acoustically through the use of the internal loudspeaker or with headphones. The frequency at which the demodulation is enabled is coupled to the markers. The sweep stops at the frequency determined by the active marker for the selected time and the RF signal is demodulated. During a measurement in the time domain (span = 0 Hz) the demodulation is continuously on.
The threshold line (*MKR->SEARCH LIMITS:THRESHOLD*) performs a squelch function in the demodulator. If the threshold is set, the FSP LF demodulation is switched on only when the signal to be demodulated exceeds the set threshold.

Menu *MKR FCTN*:



The *MARKER DEMOD* softkey switches on the audio demodulator and calls a submenu in which the demodulation mode and the duration of the demodulation can be selected.

IEC/IEEE-bus command: `CALC:MARK1:FUNC:DEM ON`

The *MKR DEMOD ON/OFF* softkey switches the demodulation on/off.

When the demodulation is on, the sweep is stopped at the frequency of the active marker, assuming the level is above the threshold, and the signal is demodulated for the duration of the defined stop time.

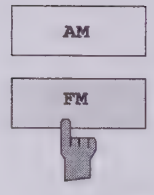
If no marker is set when the demodulation is switched on, FSP switches the first marker on (*MARKER 1*) and sets it to the largest signal.

IEC/IEEE-bus command: `CALC:MARK1:FUNC:DEM ON`

The *MKR STOP TIME* softkey defines the stop time for demodulation at the marker or markers.

FSP stops the sweep at the marker or markers for the duration of the defined stop time and then switches the demodulation on (see also *MKR DEMOD ON/OFF*).

IEC/IEEE-bus command: `CALC:MARK1:FUNC:DEM:HOLD 3s`



The *AM* and *FM* softkeys are mutually exclusive selection keys. They are used to set the desired demodulation mode, ie FM or AM.

The default setting is AM.

IEC/IEEE-bus command: `CALC:MARK1:FUNC:DEM:SEL AM`
`CALC:MARK1:FUNC:DEM:SEL FM`

Selecting the Trace

Menu *MKR FCTN*:

The *MKR→TRACE* softkey sets the active marker to different traces. Only those traces can be selected which are visible on the screen in the same window.

The function of the softkey is identical to that of the softkey with the same name in the MKR-> menu.

Example:
Three traces are displayed on the screen. The marker is always on Trace 1 on switching on.

[*MKR ->TRACE*]
"1"<ENTER> The marker jumps to Trace 2, but remains at the previous frequency or time.

[*MKR ->TRACE*]
"3"<ENTER> The marker jumps to Trace 3.

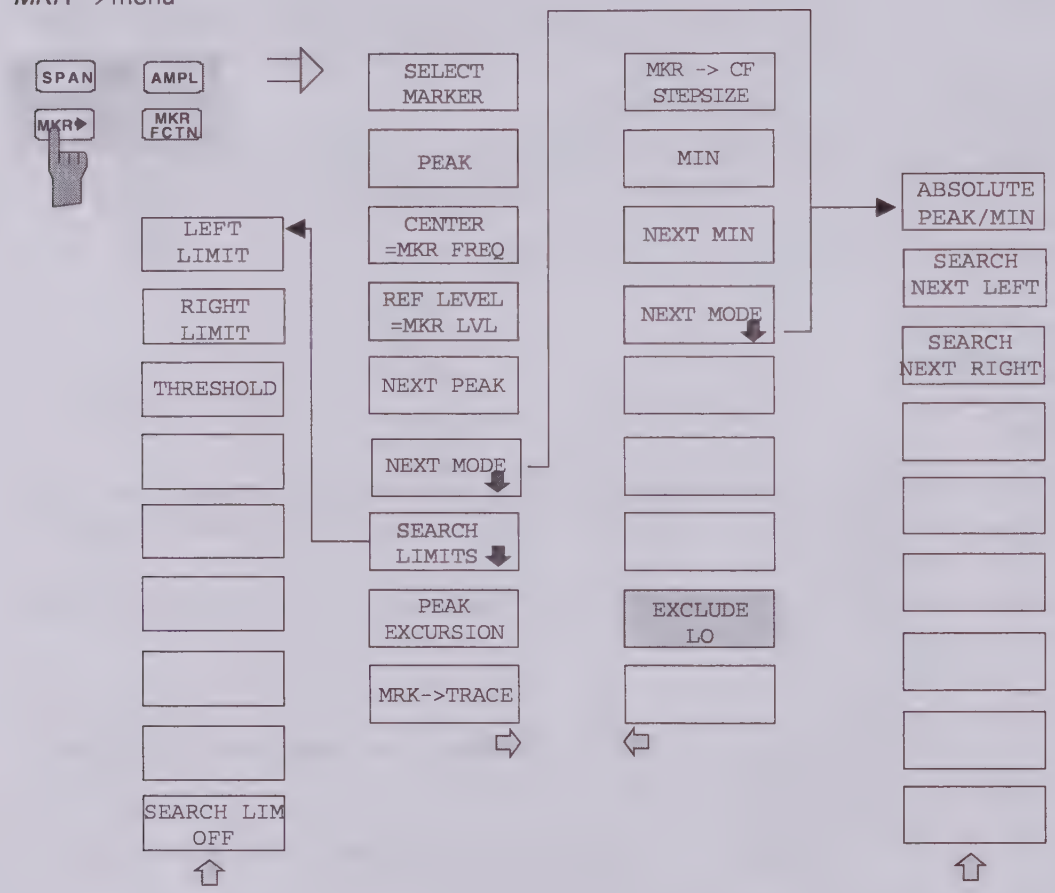
IEC/IEEE-bus command: `CALC:MARK:TRAC 2`

Change of Settings via Markers – *MKR* ⇒ Key

The *MKR* → menu offers functions through which instrument parameters can be changed with the aid of the currently active marker. The functions can be used on markers and delta markers.

On opening the menu, the entry for the last active marker is activated; if no marker was enabled, *MARKER 1* is activated and a peak search is performed.

MKR → menu



The *SELECT MARKER* softkey activates the numerical selection of the marker in the data entry field. Delta marker 1 is selected by input of ' 0 '.

IEC/IEEE-bus command:
```
CALC:MARK1 ON;
CALC:MARK1:X <value>;
CALC:MARK1:Y?
```

The *PEAK*softkey sets the active marker or delta marker to the peak of the trace.
If no marker is active when **MKR->** menu is called, *MARKER 1* is automatically switched on and the peak search is performed.

IEC/IEEE-bus command:
```
CALC:MARK:MAX
CALC:DELT:MAX
```

The *CENTER = MKR FREQ* softkey sets the center frequency to the current marker or delta marker frequency.
A signal can thus be set to the center of the frequency display range, for example, so that it can then be examined in detail with a smaller span.

The softkey is not available in the time domain (zero span).

IEC/IEEE-bus command: `CALC:MARK:FUNC:CENT`

Example:

A spectrum is displayed with a large span after PRESET. A signal off the center is to be examined in detail:

[**PRESET**]	FSP is set to the default setting.
[**MKR->**]	*MARKER 1* is switched on and automatically jumps to the largest signal of the trace.
[*CENTER =MKR FREQ*]	The center frequency is set to the marker frequency. The span is adapted in such a way that the minimum frequency (= 0 Hz) or the maximum frequency is not exceeded.
[*SPAN*]	The span can, for example, be reduced using the rollkey.

The *REF LEVEL = MKR LVL* softkey sets the reference level to the current marker level.

IEC/IEEE-bus command: `CALC:MARK:FUNC:REF`

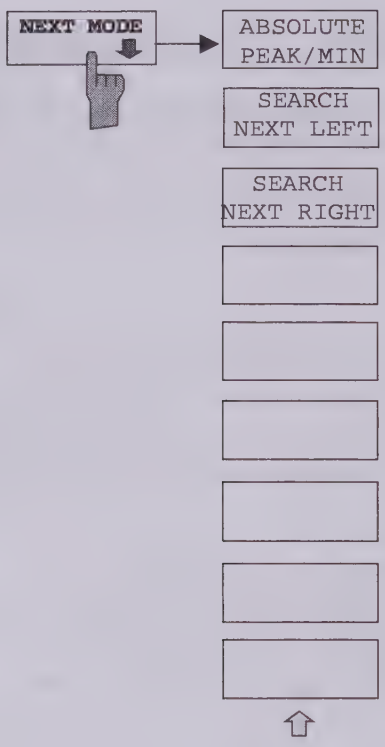
Example:

A spectrum is displayed with a large span after PRESET. A signal off the center is to be examined in detail:

[**PRESET**]	FSP is set to the default setting.
[**MKR->**]	*MARKER 1* is switched on and automatically jumps to the largest signal of the trace.
[*CENTER =MKR FREQ*]	The center frequency is set to the marker frequency. The span is adapted in such a way that the minimum frequency (= 0 Hz) or the maximum frequency is not exceeded.
[*REF LEVEL = MKR LVL*]	The reference level is set to the measured marker level.
[**SPAN**]	The span can, for example, be reduced using the rollkey.

The *NEXT PEAK* softkey sets the active marker/delta marker to the next lower peak value on the trace. The search direction is defined in the *NEXT MODE* submenu (see below).

IEC/IEEE-bus command: `CALC:MARK:MAX:NEXT`
`CALC:DELT:MAX:NEXT`

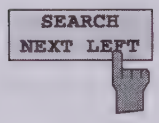


The *NEXT MODE* softkey opens a sub menu for definition of the search direction for *NEXT PEAK and NEXT MIN.*

The softkeys are selection switches, ie only one of them can be active at any one time.

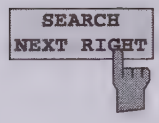
The *ABSOLUTE PEAK/MIN* softkey defines that the next higher maximum or minimum is searched for on the whole trace.

IEC-Bus-Befehle:
```
CALC:MARK:MAX:NEXT
CALC:DELT:MAX:NEXT
CALC:MARK:MIN:NEXT
CALC:DELT:MIN:NEXT
```



The *SEARCH NEXT LEFT* softkey defines that the next higher maximum or minimum on the left of the active marker is searched for, ie only frequencies or time values smaller than the current marker frequency or time are taken into account.

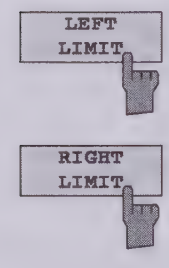
IEC-Bus-Befehle:
```
CALC:MARK:MAX:LEFT
CALC:DELT:MAX:LEFT
CALC:MARK:MIN:LEFT
CALC:DELT:MIN:LEFT
```



The *SEARCH NEXT RIGHT* softkey defines that the the next higher maximum or minimum on the right of the active marker is searched for, ie only frequencies or time values higher than the current marker frequency or time are taken into account.

IEC-Bus-Befehle:
```
CALC:MARK:MAX:RIGH
CALC:DELT:MAX:RIGH
CALC:MARK:MIN:RIGH
CALC:DELT:MIN:RIGH
```

The *SEARCH LIMITS* softkey limits the search range for maximum or minimum search. The softkey switches to a submenu in which the search range limits can be set in the x and y direction.

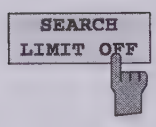


The *LEFT LIMIT* und *RIGHT LIMIT* softkeys define the two vertical lines SL1 and SL2. The search is performed between these lines in the frequency and time domain
If only one line is enabled, line SL1 is the lower limit and the upper limit corresponds to the stop frequency. If SL2 is also enabled, it determines the upper limit.

IEC/IEEE-bus command:
```
CALC:MARK:X:SLIM:LEFT 1MHZ
CALC:MARK:X:SLIM:RIGH 10MHZ
CALC:MARK:X:SLIM ON
```

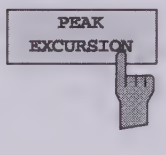
The *THRESHOLD* softkey defines the threshold line.
The threshold line represents a limit for the level range of the max. search at the lower end and that of the min. search at the upper end.

IEC/IEEE-bus command:
```
CALC:THR -20dBm
CALC:THR ON
```



The *SEARCH LIMIT OFF* softkey disables all limits of the search range.

IEC/IEEE-bus command:
```
CALC:MARK:X:SLIM OFF
CALC:THR OFF
```



The *PEAK EXCURSION* softkey activates an entry box for selecting the minimum amount by which a signal level must decrease/increase before it is recognized by the *NEXT PEAK* and *NEXT MIN* search functions as a maximum or minimum.

Input values from 0 to 80 dB are allowed, the resolution being 0.1 dB.

IEC/IEEE-bus command: `CALC:MARK:PEXC 10dB`

The peak excursion is preset to 6 dB. This is sufficient for the *NEXT PEAK* (or *NEXT MIN*) functions in the *NEXT MODE ABS* setting as always the next smaller (or larger) signal is searched for.

In the *SEARCH NEXT LEFT* or *SEARCH NEXT RIGHT* setting, functions *NEXT PEAK* and *NEXT MIN* search for the next relative maximum or minimum on the right or left of the current marker position irrespective of the instantaneous signal amplitude. A relative maximum is given when the signal amplitude on both sides of the maximum is reduced by a certain amount, ie the peak excursion.
The preset 6 dB level change can already be reached by the noise indication of the analyzer. Noise maxima are identified as peaks. In this case, *PEAK EXCURSION* has to be selected with a higher value than the difference between the highest and lowest noise indication values.

The following example shows the effect of different *PEAK EXCURSION* settings.

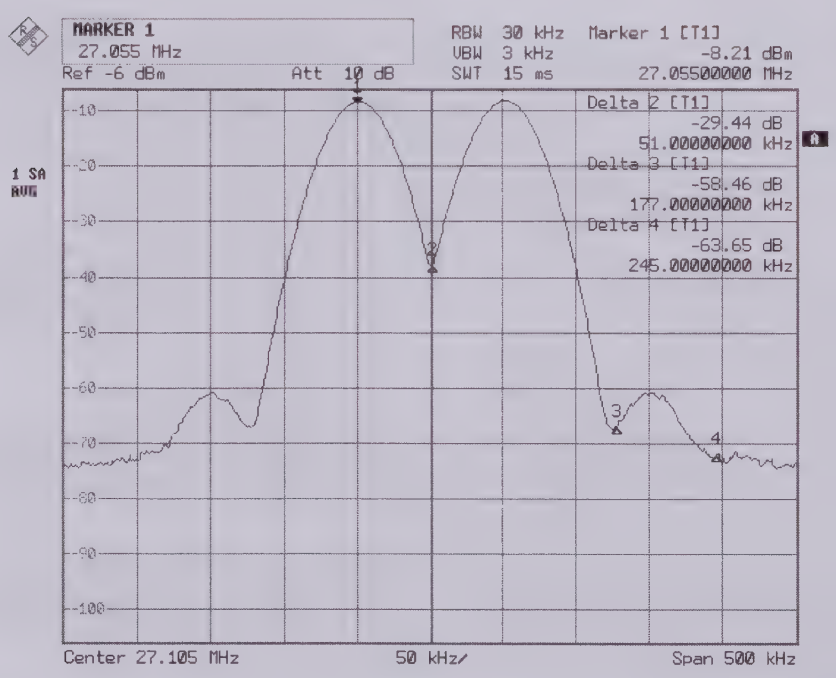


Fig. 4-7 Example for level measurements at different peak excursion settings

Maximum relative level change of the measured signals:

Signal 2:	42 dB
Signal 3	30 dB
Signal 4:	46 dB

The setting **Peak Excursion 40 dB** causes signals 2 and 4 to be detected with *NEXT PEAK* or *NEXT PEAK RIGHT*. Signal 3 is not detected since it only decreases by 30 dB before the level rises again.

Order of signals found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Signal 2
NEXT PEAK RIGHT:	Signal 4

The setting **Peak Excursion 20 dB** causes signal 3 to be detected as well since its highest level change of 30 dB is now higher than the set peak excursion.

Order of signals found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4
NEXT PEAK:	Signal 3

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Signal 2
NEXT PEAK RIGHT:	Signal 3
NEXT PEAK RIGHT:	Signal 4

The setting **Peak Excursion 6 dB** detects all the signals, *NEXT PEAK RIGHT* does not work as required.

Order of signals found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4
NEXT PEAK:	Signal 3

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2

The *MKR→TRACE* softkey sets the active marker to a new trace. If only one trace is available on the screen, the softkey does not appear. If several traces are available on the screen, only these are offered.

IEC/IEEE-bus command: `CALC:MARK:TRAC 2`

Example:

Three traces are displayed on the screen. The marker is always on Trace 1 after switching on.

[*MKR ->TRACE] "2" <ENTER>* The marker jumps to Trace 2 but remains at the previous frequency or time.

[*MKR ->TRACE*] "3" *<ENTER>* The marker jumps to Trace 3.

The *MKR→CF STEPSIZE* softkey sets the step size for the center frequency variation to the current marker frequency, and also sets step size adaptation to *MANUAL*. *CF STEPSIZE* remains at this value until the center frequency entry mode in the STEP menu is switched from *MANUAL* to *AUTO* again.

The *MKR→CF STEPSIZE* function is, above all, useful in the measurement of harmonics with large dynamic range (narrow bandwidth and narrow span).

The softkey is not available in the time domain (span = 0 Hz).

IEC/IEEE-bus command: `CALC:MARK:FUNC:CST`

Example:

The harmonics levels of a CW carrier are to be measured at 100 MHz.

[**PRESET**] FSP is set to the default setting.

[**CENTER**: 100 **MHz**] FSP sets the center frequency to 100 MHz. The span is set to 200 MHz.

[**SPAN**: 1 **MHz**] The span is set to 100 MHz.

[**MKR->**] *MARKER 1* is switched on and set to the maximum value of the signal.

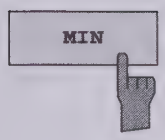
[**NEXT**] FSP switches to the submenu.

[*MKR->CF STEPSIZE*] The step size of the center frequency setting equals the marker frequency (100 MHz).

[**CENTER**] The center frequency entry mode is activated.

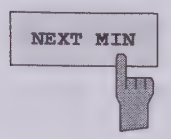
[**Right key**] The center frequency is set to 200 MHz. The first harmonic of the test signal is displayed.

[**MKR->**: *PEAK*] The marker is set to the harmonic and the level of the latter is output in the marker info field.



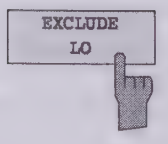
The *MIN* softkey sets the active marker to the minimum value on the corresponding trace.

IEC/IEEE-bus command: `CALC:MARK:MIN`
`CALC:DELT:MIN`



The *NEXT MIN* softkey sets the active marker to the next higher minimum value on the corresponding trace. The search direction is defined in the *NEXT MODE* submenu (see above).

IEC/IEEE-bus command: `CALC:MARK:MIN:NEXT`
`CALC:DELT:MIN:NEXT`



The *EXCLUDE LO* softkey limits the frequency range for the marker search functions or disables the limit.

activated Because of the feedthrough of the first local oscillator to the first intermediate frequency at the input mixer, the LO is represented as a signal at 0 Hz. To avoid the marker jumping to the LO at 0 Hz with the peak function when setting the display range, this frequency is excluded. The minimum frequency to which the marker jumps, is ≥ 6 × resolution bandwidth (RBW).

deactivated No restriction to the search range. The frequency 0 Hz is included in the marker search functions.

IEC/IEEE-bus command: `CALC:MARK:LOEX ON`

Power Measurements – *MEAS* Key

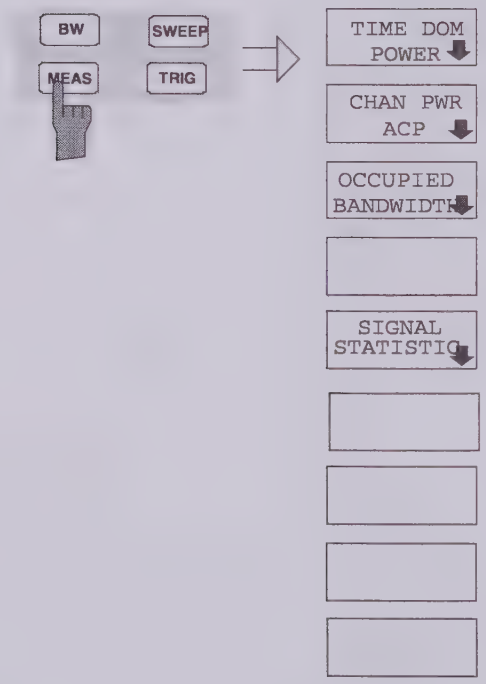
With its power measurement functions FSP is able to measure all the necessary parameters with high accuracy in a wide dynamic range.

A modulated carrier is almost always used (except eg: SSB-AM) for high-frequency transmission of information. Due to the information modulated upon the carrier, the latter covers a spectrum which is defined by the modulation, the transmission data rate and the signal filtering. Within a transmission band each carrier is assigned a channel taking into account these parameters. In order to ensure error-free transmission, each transmitter must observe the specified parameters. These include among others:

- the output power,
- the occupied bandwidth, ie the bandwidth which must contain a defined percentage of the power and
- the adjacent-channel power.

The measurements are selected and set in the *MEAS* menu.

MEAS menu:



The *MEAS* key opens the menu to select and set the power measurement.

The following measurements can be carried out:

- Power in time domain (*TIME DOM POWER*)
- Channel power and adjacent-channel power in frequency domain (*CHAN PWR /ACP*)
- Occupied bandwidth (*OCCUPIED BANDWIDTH*)
- Amplitude probability distribution (*SIGNAL STATISTICS*)

The above measurements are carried out alternatively.

Power Measurement in Time Domain

With the aid of the power measurement function FSP determines the power of the signal in the time domain (SPAN = 0 Hz) by summing up the power at the individual pixels and dividing it then by the number of pixels. In this way it is possible to measure for example the power of TDMA signals during transmission or during muting. Both the mean power and the rms power can be measured with the aid of the individual power values.
The result is displayed in the marker info field.

The measured values are updated after each sweep or averaged over a user-defined number of sweeps (*AVERAGE ON/OFF* and *NUMBER OF SWEEPS*) in order to determine eg the mean power over several bursts. For determination of the peak value (*PEAK HOLD ON*) the maximum value from several sweeps is displayed.

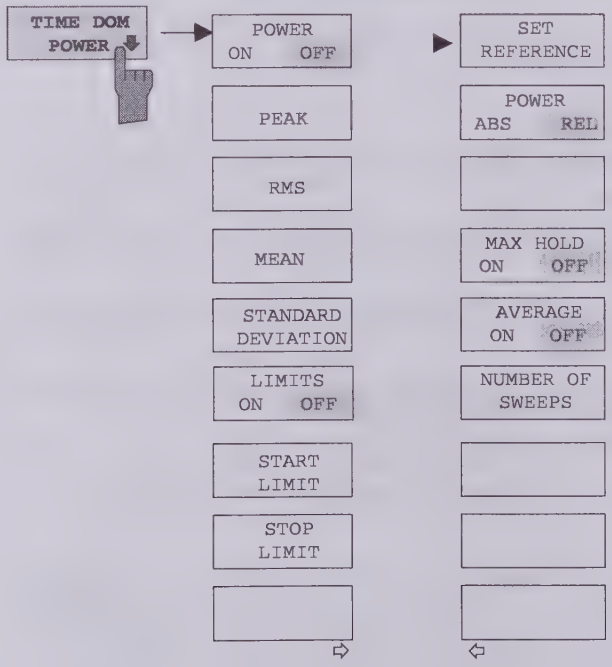
Example:
Marker info field for: *MEAN* selected, *AVERAGE ON* and *PEAK HOLD ON*:

```
MEAN HOLD      -2.33 dBm
MEAN AV        -2.39 dBm
```

If both the on and off phase of a burst signal are displayed, the measurement range can be limited to the transmission or to the muting phase with the aid of vertical lines. The signal and noise power of a TDMA signal for instance can be measured by using a measurement as a reference value and varying then the measurement range.

Upon switching on power measurement the sample detector is activated (*TRACE-DETECTOR-SAMPLE*).

Untermenü *MEAS - TIME DOM POWER*:

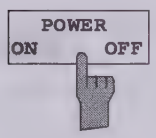


The *TIME DOM POWER* softkey activates the power measurement in the time domain and opens a submenu for configuration of the power measurement.

The submenu allows selection of the type of power measurement (rms or mean power), the settings for max hold and averaging as well as the definition of limits.

The power evaluation range can be limited by input of limit values.

Note: *This softkey can only be operated in time domain (SPAN = 0).*



The *POWER ON/OFF* softkey switches the power measurement on and off. Upon calling up the submenu it is *ON* since the power measurement is already switched on with the *TIME DOM POWER* softkey in the main menu.

Note: *The measurement is performed on the trace on which marker 1 is placed. To evaluate another trace, marker 1 should be set on another trace using the SELECT TRACE softkey in menu MKR.*

IEC/IEEE-bus command:

```
CALC:MARK:FUNC:SUMM:PPE ON
CALC:MARK:FUNC:SUMM:PPE:RES?
CALC:MARK:FUNC:SUMM:RMS ON
CALC:MARK:FUNC:SUMM:RMS:RES?
CALC:MARK:FUNC:SUMM:MEAN ON
CALC:MARK:FUNC:SUMM:MEAN:RES?
CALC:MARK:FUNC:SUMM:SDEV ON
CALC:MARK:FUNC:SUMM:SDEV:RES?
```

The *PEAK* softkey switches on the calculation of the peak value from the points of the displayed trace or a segment thereof.

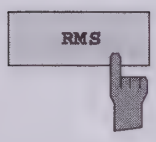
For the maximum peak, the largest peak value obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the peak values of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

IEC/IEEE-bus command:

```
CALC:MARK:FUNC:SUMM:PPE ON
CALC:MARK:FUNC:SUMM:PPE:RES?
```



The *RMS* softkey switches on the calculation of the rms value from the points of the displayed trace or a segment thereof.

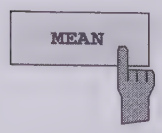
For the maximum peak, the largest rms value obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the rms values of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

IEC/IEEE-bus command:

```
CALC:MARK:FUNC:SUMM:RMS ON
CALC:MARK:FUNC:SUMM:RMS:RES?
```



The *MEAN* softkey switches on the calculation of the mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated.

This can be used for instance to measure the mean power during a GSM burst.

For the maximum peak, the largest mean value obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the mean values of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

IEC/IEEE-bus command:
```
CALC:MARK:FUNC:SUMM:MEAN ON
CALC:MARK:FUNC:SUMM:MEAN:RES?
```

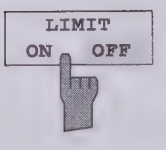
The *STANDARD DEVIATION* softkey switches on the calculation of the standard deviation of trace points from the mean value and outputs them as measured value. The measurement of the mean power is automatically switched on at the same time.

For the maximum peak, the largest standard deviation obtained since the activation of *MAX HOLD ON* is displayed.

With *AVERAGE ON*, the standard deviations of a trace are averaged over several sweeps and displayed.

The number of sweeps over which the average or the maximum value is calculated is set with the *NUMBER OF SWEEPS* softkey.

IEC/IEEE-bus command:
```
CALC:MARK:FUNC:SUMM:SDEV ON
CALC:MARK:FUNC:SUMM:SDEV:RES?
```



The *LIMIT ON/OFF* softkey selects the limited (*ON*) or non-limited (*OFF*) evaluation range.

The evaluation range is defined by the *START LIMIT* and *STOP LIMIT* softkeys. If *LIMIT = ON*, signals are only searched between the two lines.

If only one limit line is switched on, time line 1 is the lower limit and the upper limit corresponds to the stop frequency. If time line 2 is also switched on, it defines the upper limit.

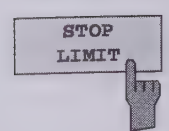
If no limit line is switched on, the evaluation range is not limited.

The default setting is *LIMIT = OFF*.

IEC/IEEE-bus command:
```
CALC:MARK:X:SLIM OFF
```

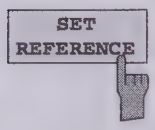
The *START LIMIT* softkey activates the entry of the lower limit of the evaluation range.

IEC/IEEE-bus command:
```
CALC:MARK:X:SLIM:LEFT <value>
```



The *STOP LIMIT* softkey activates the entry of the upper limit of the evaluation range.

IEC/IEEE-bus command:
```
CALC:MARK:X:SLIM:RIGH <value>
```

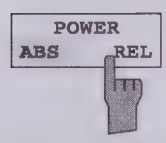


The *SET REFERENCE* softkey sets as reference values the power values currently measured for the calculation of the mean value (*MEAN)* and the rms value (*RMS)*. The reference values are used to perform relative measurements.

If the calculation of the mean value (*MEAN)* and rms value (*RMS)* is not switched on, 0 dBM is used as a reference value.

If the average value (*AVERAGE)* or maximum value (*MAX HOLD*) is calculated over several sweeps, the current value is the measured value summed up at the actual time.

IEC/IEEE-bus command: `CALC:MARK:FUNC:SUMM:REF:AUTO ONCE`



The *POWER ABS/REL* softkey selects the absolute power measurement (default setting) or relative power measurement. The reference value for the relative power is defined by *SET REFERENCE*.

The value 0 dBm is used if the reference value is not defined.

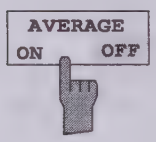
IEC/IEEE-bus command: `CALC:MARK:FUNC:SUMM:MODE ABS`

The *MAX HOLD ON/OFF* softkey switches the display of the maximum peak from successive sweep measurements on and off.

The displayed maximum peak is only updated if a higher value occurs in a sweep.

The maximum value can be reset by switching the *MAX HOLD ON / OFF* softkey off and on again.

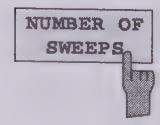
IEC/IEEE-bus command:
```
CALC:MARK:FUNC:SUMM:PHOL ON
CALC:MARK:FUNC:SUMM:PPE:PHOL:RES?
CALC:MARK:FUNC:SUMM:RMS:PHOL:RES?
CALC:MARK:FUNC:SUMM:MEAN:PHOL:RES?
CALC:MARK:FUNC:SUMM:SDEV:PHOL:RES?
```



The *AVERAGE ON/OFF* softkey switches averaging over successive sweep measurements on and off.

The measured values can be reset by switching the *AVERAGE ON / OFF* softkey off and on again.

IEC/IEEE-bus command:
```
CALC:MARK:FUNC:SUMM:AVER ON
CALC:MARK:FUNC:SUMM:PPE:AVER:RES?
CALC:MARK:FUNC:SUMM:RMS:AVER:RES?
CALC:MARK:FUNC:SUMM:MEAN:AVER:RES?
CALC:MARK:FUNC:SUMM:SDEV:AVER:RES?
```



The *NUMBER OF SWEEPS* softkey activates the entry of the number of sweeps for maximum or average value determination.

SINGLE SWEEP mode	FSP performs sweeps until the set number is attained and then stops.
CONTINUOUS SWEEP mode	Averaging is carried out until the set number of sweeps is reached and is then continued as running averaging. Determination of the maximum peak (*MAX HOLD*) is continuous irrespective of the set number of sweeps.

The permissible range of values is 0 to 32767.

Depending on the specified number of sweeps, averaging is carried out according to the following rules:

NUMBER OF SWEEPS = 0	Running averaging is carried out over 10 measured values.
NUMBER OF SWEEPS = 1	No averaging is carried out.
NUMBER OF SWEEPS > 1	Averaging is carried out over the set number of measured values.

Note: *This setting is equivalent to the setting of the sweep number in the TRACE menu.*

IEC/IEEE-bus command: `SWE:COUN <value>`

Example:

The mean power of a GSM burst with 0 dBm nominal power at 800 MHz is to be measured.

[**PRESET**]	Set FSP to the default setting.
[**FREQ:** *CENTER*: 800 **MHz**]	Set the center frequency to 800 MHz.
[**SPAN**: *ZERO SPAN*]	Select time domain display (span = 0 Hz).
[**AMPT**: 0 **dBm**]	Set the reference level to 0 dBm.
[**BW**: *RES BW MANUAL*: 30 **kHz**]	Set the resolution bandwidth to 30 kHz in line with the requirements of the GSM standard.
[**SWEEP**: *SWEEPTIME MANUAL* 600 µs]	Set the sweep time to 600 µs.
[**TRIG**: *VIDEO*: 50 **%**]	Use the video signal as trigger source.
[**MEAS**]	Call the menu for the measurement functions.
[*TIME DOM POWER*]	Select power measurement in the time domain. FSP calculates the mean power from the points of the whole trace. The submenu for configuration of the power measurement is opened. *MEAN* is already switched on.
[*LIMITS ON*]	Activate the limitation of the time domain of the power measurement .
[*START LIMIT*: 250 **µs**]	Set the start of the power measurement at 250 µs.
[*STOP LIMIT*: 500 **µs**]	Set the end of the power measurement at 500 µs.

Note: *The GSM specifications require the power to be measured between 50% and 90% of the TDMA burst. The time limits set above approximately correspond to the required time domain.*

Channel and Adjacent-Channel Power Measurements

For all channel and adjacent-channel power measurements a specified channel configuration is assumed which is for instance based on a specific radiocommunication system.
This configuration is defined by the nominal channel frequency (= center frequency of FSP), channel bandwidth, adjacent-channel bandwidth and adjacent-channel spacing. FSP is able to simultaneously measure the power in up to three adjacent channels (7 channels: transmission channel, 3 lower and 3 upper adjacent channels).
The transmission channel and the adjacent channels are marked on the screen by vertical lines spaced half the channel bandwidth to the left and right of the channel center frequency (see Fig. 4-8).
For some standards, the channel power and the adjacent-channel power have to be weighted by a root-cosine filter corresponding to the receiver filter. This filter is automatically switched on upon selection of the corresponding standard (eg NADC or TETRA).

The power measurement is carried out by integrating the testpoints within the channel bandwidth in the spectrum display mode.

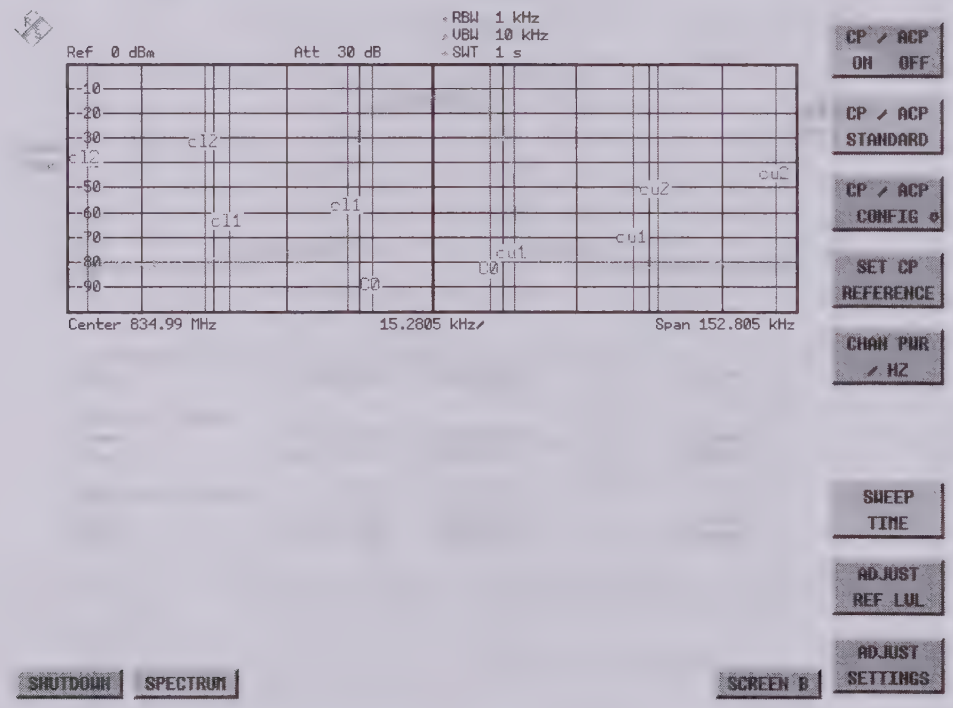
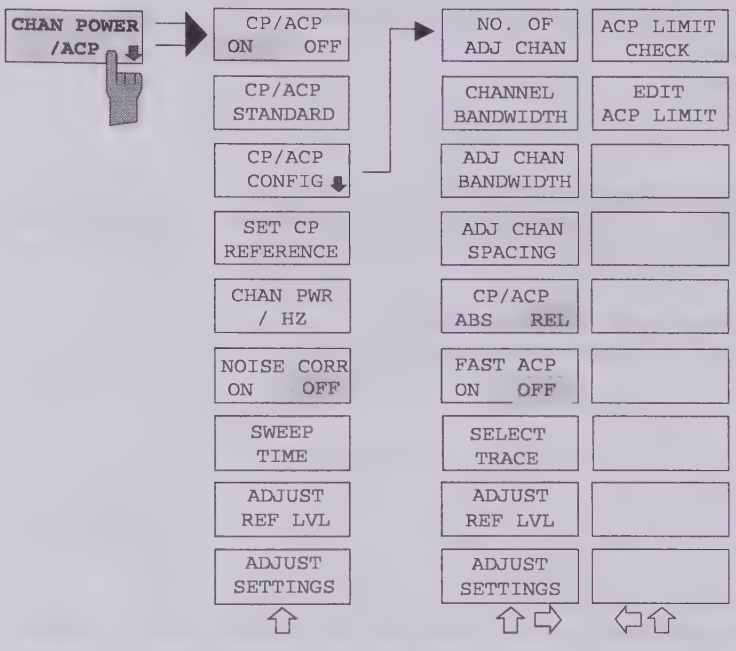


Fig. 4-8 Defining the channel bandwidth

Limit values can be defined for the power measurement in the adjacent channels. If the limit check function is activated, a pass/fail information with indication of the exceeded power level is output upon measurement.

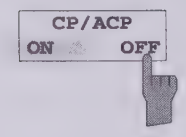
Note: *With the CP/ACP measurement switched on the functions SPLIT SCREEN and FULL SCREEN are inhibited the same as the selection of the active diagram with SCREEN A / SCREEN B.*

The channel configuration is defined in the *MEAS CHAN POWER/ACP* menu.



The *CHAN POWER /ACP* softkey switches on channel power measurement or adjacent-channel power measurement according to the current configuration. At the same time it opens the submenu for defining the channel power measurement. The softkey is highlighted to show that channel or adjacent-channel power measurement is on.

Note: *This softkey can only be operated in frequency domain (SPAN > 0).*



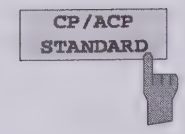
The *CP/ACP ON/OFF* softkey switches the calculation of the channel power or adjacent-channel power on or off.

The calculation is made by integrating the power at the pixels within the specified channel.

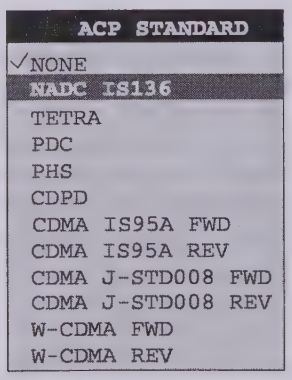
The measurement is either absolute or relative to a reference power (see *CP/ACP ABS/ REL* softkey).

IEC/IEEE-bus command:

```
CALC:MARK:FUNC:POW:SEL CPOW|ACP
CALC:MARK:FUNC:POW:RES? CPOW|ACP
CALC:MARK:FUNC:POW OFF
```



The *CP/ACP STANDARD* softkey activates the selection of a digital mobile radio standard. The parameters for the channel or adjacent-channel power measurement are set according to the specifications of the selected mobile radio standard.



The following standards may be selected:

NADC IS136
TETRA
PDC (RCR STD-27)
PHS (RCR STD-28)
CDPD
CDMA IS95A FWD
CDMA IS95A REV
CDMA J-STD008 FWD
CDMA J-STD008 REV
W-CDMA FWD
W-CDMA REV

The selection of the standard influences the following parameters:

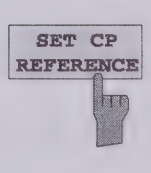
- channel spacing
- channel bandwidth
- modulation filter
- resolution bandwidth
- video bandwidth
- detector

Trace math and trace averaging functions are switched off.
The reference level is not influenced by automatic adjustment. For an optimum dynamic range it should be set so that the signal maximum is in the vicinity of the reference level.

The default setting is CP/*ACP STANDARD NONE*.

IEC/IEEE-bus command: `CALC:MARK:FUNC:POW:PRES <standard>`

See following section "Setting the Channel Configuration"



With channel power measurement activated, the *SET CP REFERENCE* softkey defines the currently measured channel power as the reference value. The reference value is displayed in the *CH PWR REF* field; the default value is 0 dBm.

With adjacent-channel power measurement activated, the transmission channel is defined as the reference.

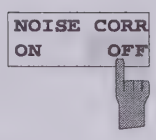
IEC/IEEE-bus command: `POW:ACH:REF:AUTO ONCE`

The *CHAN PWR / HZ* softkey selects the measurement of the total channel power or the measurement of the channel power referred to 1 Hz bandwidth. The conversion factor is

$$10 \cdot \lg \frac{1}{\text{Channel} \cdot \text{Bandwidth}}.$$

This function allows for instance measurement of the noise power density or, in conjunction with the *CP/ACP REL* and *SET CP REFERENCE* functions, measurement of the signal-to-noise power density.

IEC/IEEE-bus command: `CALC:MARK:FUNC:POW:RES:PHZ ON|OFF`

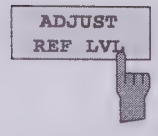


The *NOISE CORR ON/OFF* softkey switches on the correction of results by the inherent noise, thus increasing the dynamic range. On switching on the function a reference measurement of the inherent noise is first performed. The measured noise power is then substracted from the power of the examined channel.
For each modification of center frequency, resolution bandwidth, sweep time and level setting the inherent noise measuremnt is switched off. To repeat the reference measurement at the new setting, the softkey has to be pressed again.

IEC/IEEE-bus command: `SENS:POW:NCOR ON`

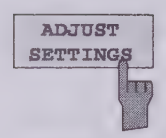
The *SWEEP TIME* softkey sets the measurement time for calculation of the signal statistic.
The function of the softkey is identical to the softkey *SWEEP TIME MANUAL* in the menu *BW*.

IEC/IEEE-bus command: `SWE:TIM <value>`



The *ADJUST REF LVL* softkey adjusts the reference level of FSP to the measured channel power to ensure that the signal path of FSP is not overdriven.
Since the measurement bandwidth for channel power measurements is significantly lower than the signal bandwidth, the signal path may be overdriven although the trace is distinctly below the reference level. If the measured channel power is equal to the reference level, the signal path cannot be overdriven.

IEC/IEEE-bus command: `SENS:POW:ACH:PRES:RLEV`



The *ADJUST SETTINGS* softkey automatically optimizes the analyzer settings for the selected power measurement (see below).
All analyzer settings relevant for a power measurement within a specific frequency band (channel bandwidth) are optimized for the selected channel configuration (channel bandwidth, channel spacing):

- Frequency span:

  The span should cover at least the frequency range to be investigated. In case of the channel power measurement this is

  2 x channel bandwidth

  In case of the adjacent-channel power measurement it is the channel spacing and the channel bandwidth of the adjacent channels with the largest spacing from the transmission channel (ADJ, ALT1 or ALT2).

  2 × (channel spacing + channel bandwidth)

- Resolution bandwidth RBW ≤ 1/40 of channel bandwidth
- Video bandwidth VBW ≥ 3 × RBW
- Detector RMS detector

Trace math and trace averaging functions are switched off.
The reference level is not influenced by *ADJUST SETTINGS*. It can be separately adjusted with *ADJUST REF LVL*.

The adjustment is carried out only once; if necessary, the instrument settings can be changed later.

IEC/IEEE-bus command: `SENS:POW:ACH:PRES ACP|CPOW|OBW`

For manual setting of the test parameters different from the settings made with *ADJUST SETTINGS* the following should be observed:

Frequency span

The frequency span should cover at least the frequency range to be investigated.
In case of the channel power measurement this is the channel bandwidth.
If the frequency span is large compared to the frequency range(s) investigated, only a few points of the trace are available for the measurement.

Frequency span = 2 × channel bandwidth

Resolution bandwidth (RBW)

In order to ensure an acceptable measurement speed, detection of all spectral components occurring in the investigated channel as well as the required filtering (for suppression of spectral components outside the frequency range to be measured, especially the adjacent channels), the resolution bandwidth should neither be too narrow nor too wide.
For narrow resolution bandwidths, the measurement speed will considerably slow down and relevant spectral components may not be displayed (due to the sample detector required for effective power measurement and the finite number of points).
On the other hand, the resolution bandwidth should not be too wide so that due to insufficient filtering spectral components outside the frequency range investigated (adjacent channel) may invalidate the measurement result.

The *ADJUST SETTINGS* softkey sets the resolution bandwidth (RBW) as a function of the channel bandwidth as follows:

RBW ≤ 1/40 of channel bandwidth.

The largest possible RBW with regard to the available step size (1, 3) and in compliance with the requirement RBW ≤1/40 will be selected.

Video bandwidth (VBW)

Since the power of noise components should also be measured (otherwise error will occur due to the logarithmic characteristic of the spectrum analyzer), the video bandwidth should be distinctly larger than the resolution bandwidth.

The *ADJUST SETTINGS* softkey sets the video bandwidth (VBW) as a function of the channel bandwidth as follows:

VBW ≥ 3 × RBW.

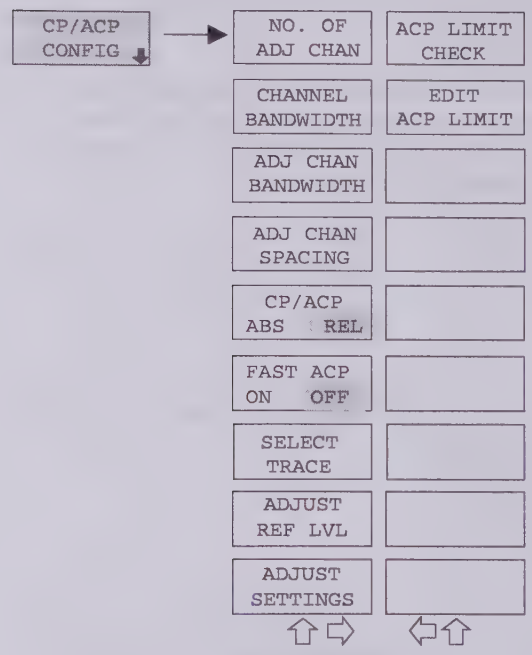
The smallest possible VBW with regard to the available step size (1, 3) will be selected.

Detector

The *ADJUST SETTINGS* softkey selects the RMS detector.
The sample or RMS detector is to be selected especially for correct power measurement of noise signals within the frequency range investigated.

Setting the Channel Configuration

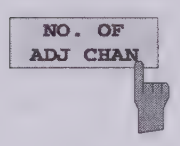
MEAS - CP/ACP CONFIG submenu:



The *CP/ACP CONFIG* softkey opens a submenu for configuration of the measurement if a channel configuration that is different from the standards offered is required.

The channel configuration comprises the number of adjacent channels to be measured, the channel bandwidth (*CHANNEL BANDWIDTH*), the bandwidth of the adjacent channels (*ADJ CHANNEL BANDWIDTH*) and the spacing of the adjacent channels from the center frequency of the transmission channel (*ADJ CHANNEL SPACING*).

Limit values can additionally be specified for the adjacent-channel power (*ACP LIMIT CHECK* and *EDIT ACP LIMITS*) which are checked for compliance during the measurement.



The *NO. OF ADJ CHAN* softkey activates the entry of the number ±n of adjacent channels to be considered in the adjacent-channel power measurement.
Numbers from 0 to 3 can be entered.

The following measurements are carried out depending on the number of the channels.

0 The channel power is measured only.

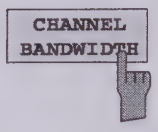
1 The channel power and the power of the upper and lower adjacent channel are measured.

2 The channel power, the power of the upper and lower adjacent channel and of the next higher and lower channel (alternate channel 1) are measured.

3 The channel power, the power of the upper and lower adjacent channel, the power of the next higher and lower channel (alternate channel 1) and of the next but one higher and lower adjacent channel (alternate channel 2) are measured.

All measured powers are indicated separately in a list on the screen.

IEC/IEEE-bus command: `POW:ACH:ACP 1`



The *CHANNEL BANDWIDTH* softkey activates the entry of the channel bandwidth for the transmission channel.

The useful channel bandwidth is generally determined by the transmission method. It is automatically adjusted to the correct setting for the measurement to a predefined standard (see *CP/ACP STANDARD* softkey).

The channel bandwidth is displayed by two vertical lines on the left and the right of the screen center. Thus it is possible to check visually whether the total signal power to be measured is within the selected channel bandwidth.

The default setting is 14 kHz.

IEC/IEEE-bus command: `SENS:POW:ACH:BWID 14kHz`

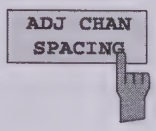
The ADJ *CHAN BANDWIDTH* softkey opens a table for defining the channel bandwidths for the adjacent channels.

ACP CHANNEL BW	
CHAN	BANDWIDTH
ADJ	30 kHz
ALT1	30 kHz
ALT2	30 kHz

Since all adjacent channels usually have the same bandwidth, entry of the adjacent-channel bandwidth (ADJ) causes the other channels ALT1 and ALT2 to be set to the bandwidth of the adjacent channel too. Thus only one value need to be entered in case of equal adjacent channel bandwidths. The same holds true for the ALT2 channels when the bandwidth of the ALT1 channel is entered.
If the bandwidths of the adjacent channels differ from the channel bandwidth, the softkey is highlighted.

Note: *The bandwidths can be separately set by overwriting the table from top to bottom.*

IEC/IEEE-bus command:
```
SENS:POW:ACH:BWID:ACH 1kHz
SENS:POW:ACH:BWID:ALT1 14kHz
SENS:POW:ACH:BWID:ALT2 14kHz
```



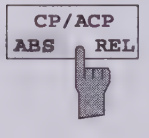
The ADJ *CHAN SPACING* softkey opens a table for defining the channel spacings.

ACP CHANNEL SPACING	
CHAN	SPACING
ADJ	800 kHz
ALT1	1.60 MHz
ALT2	2.40 MHz

Since all the adjacent channels often have the same spacing from each other, entry of the adjacent-channel spacing (ADJ) causes channel ALT1 to be set to twice and channel ALT2 to three times the adjacent-channel spacing. Thus only one value needs to be entered in case of equal channel spacing. The same holds true for the ALT2 channels when the bandwidth of the ALT1 channel is entered.

Note: *The channel spacings can be set separately by overwriting the table from top to bottom.*

IEC/IEEE-bus command:
```
SENS:POW:ACH:SPAC:ACH 20kHz
SENS:POW:ACH:SPAC:ALT1 40kHz
SENS:POW:ACH:SPAC:ALT2 60kHz
```



The *CP/ACP ABS/REL* softkey (channel power absolute/relative) switches between absolute and relative power measurement in the channel.

CP/ACP ABS The absolute power in the transmission channel and in the adjacent channels is displayed in the unit of the Y axis, eg in dBm, dBµV.

CP/ACP REL In the case of adjacent-channel power measurement (*NO. OF ADJ CHAN* > 0) the level of the adjacent channels is displayed relative to the level of the transmission channel.

In the case of channel power measurement (*NO. OF ADJ CHAN* = 0) the power of a transmission channel is displayed relative to the power of a reference channel defined with *SET CP REFERENCE*. This means:

1. Declare the power of the currently measured channel as the reference value using the *SET CP REFERENCE* softkey.
2. Set the channel of interest by varying the channel frequency (FSP center frequency).

With linear scaling of the Y axis, the power of the new channel relative to the reference channel (CP/CP_{ref}) is displayed. With dB scaling, the logarithmic ratio $10lg\ (CP/CP_{ref})$ is displayed.

The relative channel power measurement can thus also be used for universal adjacent-channel power measurements. Each channel can be measured individually.

IEC/IEEE-bus command: `SENS:POW:ACH:MODE ABS`

The *FAST ACP ON/OFF* softkey switches on or off the fast channel/adjacent channel power measurement.

With FAST ACP the power measurement is performed in the different channels in the time domain. The FSP sets the center frequency consecutively to the different channel center frequencies and measures the power with the set measurement time (= sweep time\number of channels). The RBW filter suitable for the selected standard and frequency offset are automatically used (eg root raised cos with IS 136).

The RMS detector is used for obtaining a correct power measurement. This requires no software correction factors.

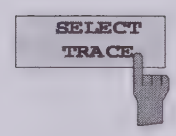
The measured values are tabulated, the power in the useful channel being indicated in dBm and the power in the adjacent channels in dBm (CP/ACP ABS) or dB (CP/ACP REL).

The sweep time is selected depending on the desired reproducibility of results. Reproducibility increases with sweep time since power measurement is performed over a longer period.

As a rule of thumb, it can be assumed that approx. 500 non-correlated measured values (does not apply to white noise) are required for a reproducibility of 0.5 dB (99% of the measurements are within 0.5 dB of the true measured value). The measured values are considered as non-correlated when their time interval corresponds to the reciprocal of the measured bandwidth.

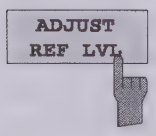
With IS 136 the measurement bandwidth is approx. 25 Hz, ie measured values at an interval of 40 µs are considered as non-correlated. A measurement time of 10 ms is thus required per channel for 1000 measured values. This is the default sweep time which the FSP sets in the coupled mode. Approx. 5000 measured values are required for a reproducibility of 0.1 dB (99%), ie the measurement time is to be increased to 200 ms.

IEC/IEEE-bus command `SENS:POW:HSP ON`

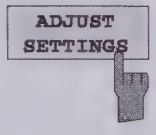


The *SELECT TRACE* softkey selects the trace, on which the CP/ACP measurement runs. Only traces can be selected, which are not set to BLANK (= switched on).

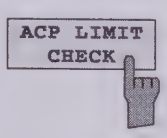
IEC/IEEE-bus command: `SENS:POW:TRAC 1`



See main menu *CHAN PWR ACP*.



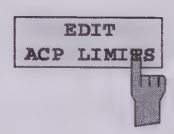
See main menu *CHAN PWR ACP*.



The *ACP LIMIT CHECK* softkey switches the limit check for the ACP measurement on and off.

IEC/IEEE-bus command:

```
CALC:LIM:ACP ON
CALC:LIM:ACP:ACH:RES?
CALC:LIM:ACP:ALT:RES?
```



The *EDIT ACP LIMITS* softkey opens a table for defining the limits for the ACP measurement.

ACP LIMITS

Chan	rel. Limit Check		abs Limit Check	
	Value	On	Value	On
ADJ	-50 dB	√		
ALT1	-60 dB	√		
ALT2			-13 dBm	√

The limits are subject to the following rules:

- A separate limit can be defined for each adjacent channel. The limit applies to both the upper and the lower adjacent channel.
- A relative and/or absolute limit can be defined. The check of both limit values can be activated independently.
- FSP checks adherence to the limits irrespective of whether the limits are absolute or relative or wether the measurement is carried out with absolute or relative levels. If both limits are active and if the higher of both limit values is exceeded, the measured value is marked accordingly.

Note: *Measured values exceeding the limit are preceded by an asterisk.*

IEC/IEEE-bus command:

```
CALC:LIM:ACP ON
CALC:LIM:ACP:ACH 0dB,0dB
CALC:LIM:ACP:ACH:STAT ON
CALC:LIM:ACP:ACH:ABS -10dBm,-10dBm
CALC:LIM:ACP:ACH:ABS:STAT ON
CALC:LIM:ACP:ALT1 0dB,0dB
CALC:LIM:ACP:ALT1:STAT ON
CALC:LIM:ACP:ALT1:ABS -10dBm,-10dBm
CALC:LIM:ACP:ALT1:ABS:STAT ON
CALC:LIM:ACP:ALT2 0dB,0dB
CALC:LIM:ACP:ALT2:STAT ON
CALC:LIM:ACP:ALT2:ABS -10dBm,-10dBm
CALC:LIM:ACP:ALT2:ABS:STAT ON
```

Examples:

1. Measurement of adjacent-channel power for a specific standard:

The adjacent-channel power is to be measured for a signal at 800 MHz with 0 dBm level in line with IS54.

[**PRESET**]	Set FSP to the default setting.
[**FREQ**: *CENTER*: 800 **MHz**]	Set the center frequency to 800 MHz.
[**AMPT**: 0 **dBm**]	Set the reference level to 0 dBm.
[**MEAS**]	Call the menu for the measurement functions.
[*CHAN PWR / ACP*]	Select the channel and adjacent-channel power measurement function. The measurement is carried out with the default setting or a previously defined setting. The submenu for setting the desired new configuration is opened.
[*CP/ACP STANDARD*: select NADC: **ENTER**]	Select the NADC standard.
[*CP/ACP CONFIG*]	Call the submenu for configuration of the adjacent-channel power measurement.
[*NO. OF ADJ CHAN*: 2 **ENTER**]	Select two adjacent channels for the measurement, ie the adjacent channel and the alternate channel are measured.
PREV	Change to the main menu for channel power measurement.
[*ADJUST SETTINGS*]	Set the optimum span, resolution bandwidth (RBW), video bandwidth (VBW) and detector automatically for the measurement. The absolute channel power and the level relative to the channel power of the adjacent channels are displayed on the screen.
[*ADJUST REF LVL*]	Set reference level equal to the channel power measured.

2. Measurement with user-specific channel configuration:

Measurement of the adjacent-channel power ratio (ACPR) of an IS95 CDMA signal at 800 MHz, level 0 dBm. Similar to example 1, the setting can be simplified by using *CP/ACP STANDARD*.

[**PRESET**] Set FSP to the default setting.

[**FREQ:** *CENTER*: 800 **MHz**] Set the center frequency to 800 MHz.

[**AMPT**: 0 **dBm**] Set the reference level to 0 dBm.

[**MEAS**] Call the menu for the measurement functions.

[*CHAN PWR / ACP*] Select the channel and adjacent-channel power measurement function. The measurement is carried out with the default setting or a previously defined setting. The submenu for setting the desired new configuration is opened.

[*CP/ACP CONFIG*] Call the submenu for defining the channel configuration.

[*NO. OF ADJ CHAN*: 2 **ENTER**] Select two adjacent channels for the measurement, ie the adjacent channel and the alternate channel are measured.

[*CHANNEL BANDWIDTH*: 1.23 **MHz**] Set the channel bandwidth to 1.23 MHz in line with IS95.

[*ADJ CHAN BANDWIDTH*: 30 **kHz**] Open the list for setting the bandwidth of the adjacent channels.

ACP CHANNEL BW	
CHAN	BANDWIDTH
ADJ	30 kHz
ALT1	30 kHz
ALT2	30 kHz

Upon entry of 30 kHz for the adjacent channel the alternate channels are also set to 30 kHz.

[*ADJ CHAN SPACING*: 885 **kHz:** ↓: 1.98 **MHz**] Open the list for entering the adjacent-channel spacings.

ACP CHANNEL SPACING	
CHAN	SPACING
ADJ	885 kHz
ALT1	1.98 MHz
ALT2	2.97 MHz

Upon entry of 885 kHz for the adjacent channel the channels ALT1 and ALT2 are set to 1770 kHz and 2655 kHz. Upon entry of 1.98 MHz for the alternate channel 1 the alternate channel 2 is set to 2.97 MHz.

PREV In dasHauptmenü für die Kanalleistungsmessung wechseln.

[*ADJUST SETTINGS*] Set automatically the optimum span (= 5 MHz), resolution bandwidth (RBW = 30 kHz), video bandwidth (VBW = 300 kHz) and detector (RMS) for the measurement. The absolute channel power and the level relative to the channel power of the adjacent channels and alternate channels are displayed on the screen.

[*ADJUST REF LVL*] Set the reference level equal to the channel power measured.

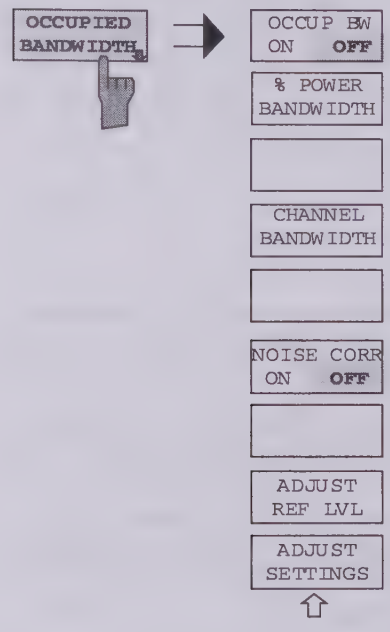
3. Measurement of signal/noise power density (C/No) of an IS95 CDMA signal (frequency 800 MHz, level 0 dBm)

[**PRESET**]	Set FSP to the default setting.
[**FREQ:** *CENTER*: 800 **MHz**]	Set the center frequency to 800 MHz.
[**AMPT**: 0 **dBm**]	Set the reference level to 0 dBm.
MEAS]	Call the menu for the measurement functions.
[*CHAN PWR / ACP*]	Select the channel and adjacent-channel power measurement. The measurement is carried out with the default setting or a previously defined setting. The submenu for setting the desired new configuration is opened.
[*CP/ACP CONFIG*]	Call the submenu for defining the channel configuration.
[*NO. OF ADJ CHAN*: 0 **ENTER**]	Do not select an adjacent channel for the measurement, ie the measurement is carried out in one channel only.
[*CHANNEL BANDWIDTH*: 1.23 **MHz**]	Set the channel bandwidth to 1.23 MHz in line with IS95.
PREV	Change to the main menu for channel power measurement
[*ADJUST SETTINGS*]	Set the optimum span (= 5 MHz), resolution bandwidth (RBW = 30 kHz), video bandwidth (VBW = 300 kHz) and detector (RMS) for the measurement automatically. The absolute channel power and the level relative to the channel power of the adjacent channels and alternate channels are displayed on the screen.
[*ADJUST REF LVL*]	Set the reference level equal to the channel power measured.
[*SET CP REFERENCE*]	Set the measured channel power as a reference for the subsequent measurements.
[*CP/ACP ABS / REL*]	Select relative measurement referred to the reference power set with *SET REFERENCE* (result 0 dB).
[*CHAN PWR / HZ*]	Select power measurement relative to 1 Hz bandwidth (result -60.9 dB).
[**FREQ:** *CENTER*: 805 **MHz**]	Set the center frequency to 805 MHz. FSP measures the channel power at 1.23 MHz bandwidth and outputs the result in dB relative to the reference power and 1 Hz bandwidth.

Measurement of Occupied Bandwidth

An important characteristic of a modulated signal is its occupied bandwidth. In a radio communications system for instance the occupied bandwidth must be limited to enable disturbance-free transmission in adjacent channels. The occupied bandwidth is defined as the bandwidth containing a defined percentage of the total transmitter power. A percentage between 10% and 99.9% can be set on FSP.

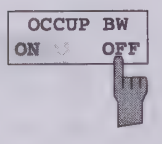
MEAS OCCUPIED BANDWIDTH menu:



The *OCCUPIED BANDWIDTH* softkey activates measurement of the occupied bandwidth according to the current configuration and it opens the submenu for configuring the measurement. The softkey is only available in frequency domain (span >0) and is highlighted when the measurement is switched on.

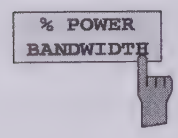
In the spectrum display mode, this measurement determines the bandwidth containing a predefined percentage of the power of the displayed frequency range (*% POWER BANDWIDTH* softkey). The occupied bandwidth is output in the marker display field and marked on the trace by temporary markers.

Note:
- *The softkey is only available in frequency domain (span >0).*
- *The measurement is accomplished on the trace with marker 1. In order to evaluate another trace, marker 1 must be placed on another trace by means of SELECT TRACE in the MKR menu*



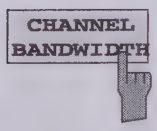
The *OCCUP BW ON/OFF* softkey switches measurement of the occupied bandwidth on or off.

IEC/IEEE-bus command:
```
CALC:MARK:FUNC:POW:SEL OBW
CALC:MARK:FUNC:POW:RES? OBW
CALC:MARK:FUNC:POW OFF
```



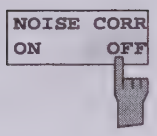
The *% POWER BANDWIDTH* softkey opens a field for entry of the percentage of power referred to the total power in the displayed frequency range which defines the occupied bandwidth (percentage of total power).
The permissible range of values is 10% to 99.9%.

IEC/IEEE-bus command:
```
SENS:POW:BWID 99PCT
```



The *CHANNEL BANDWIDTH* softkey opens an input window for defining the channel bandwidth for the transmission channel. For measurements in line with a specific transmission standard, the bandwidth specified by the standard for the transmission channel must be entered.
The default setting is 14 kHz.
The specified channel bandwidth is used for optimization of the test parameters of FSP with *ADJUST SETTINGS*.

IEC/IEEE-bus command: `SENS:POW:ACH:BWID 14kHz`

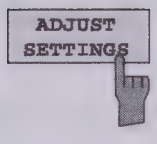


The *NOISE CORR ON/OFF* softkey switches the correction of results by the inherent noise, thus increasing the dynamic range (see also *MEAS CHAN POWER/ACP* menu).

IEC/IEEE-bus command: `SENS:POW:NCOR ON`

The *ADJUST REF LVL* softkey adjusts the reference level of FSP to the measured total power of the signal. The softkey is activated after the first sweep with the measurement of the occupied bandwidth has been completed and the total power of the signal is thus known.
Adjusting the reference level ensures that the signal path of FSP will not be overdriven and the dynamic range not limited by too low a reference level.
Since the measurement bandwidth for channel power measurements is significantly lower than the signal bandwidth, the signal path may be overdriven although the trace is distinctly below the reference level. If the measured channel power is equal to the reference level, the signal path cannot be overdriven.

IEC/IEEE-bus command: `SENS:POW:ACH:PRES:RLEV`



The *ADJUST SETTINGS* softkey optimizes the analyzer settings for the measurement of the occupied bandwidth according to the specified channel bandwidth.
All analyzer settings relevant for power measurement within a specific frequency range, such as

- frequency span — 3 x channel bandwidth
- resolution bandwidth — RBW ≤ 1/40 of channel bandwidth
- video bandwidth — VBW ≥ 3 × RBW
- detector — RMS

are optimized.

The reference level is not influenced by *ADJUST SETTINGS*. For an optimum dynamic range it should be set so that the signal maximum is in the vicinity of the reference level.

The adjustment is carried out only once; if necessary, the instrument settings may be changed later.

IEC/IEEE-bus command: `SENS:POW:PRES OBW`

Measurement principle:

For example, the bandwidth containing 99% of the signal power is to be determined. The routine first calculates the total power of all displayed points of the trace. In the next step, the points from the right edge of the trace are summed up until 0.5% of the total power is reached. Auxiliary marker 1 is positioned at the corresponding frequency. Then FSP sums up the points from the left edge of the trace until 0.5% of the power is reached. Auxiliary marker 2 is positioned at this point. 99% of the power is now between the two markers. The distance between the two frequency markers is the occupied bandwidth which is displayed in the marker info field.
A prerequisite for correct measurement is that only the signal to be measured is visible on the screen of FSP. An additional signal would invalidate the measurement.

To ensure correct power measurement especially for noise signals and to obtain the correct occupied bandwidth, the following settings should be selected:

RBW	<< occupied bandwidth (approx. 1/20 of occupied bandwidth, for voice communication type. 300 Hz or 1 kHz)
VBW	≥ 3 x RBW
Detector	RMS or sample
Span	≥2 to 3 x occupied bandwidth

Some of the measurement specifications (eg PDC, RCR STD-27B) prescribe measurement of the occupied bandwidth using a peak detector. The detector setting of FSP has then to be changed accordingly.

Example:
Measurement of occupied bandwidth of a PDC signal at 800 MHz, level 0 dBm

[**PRESET**]	Set FSP to the default setting.
[**FREQ**: *CENTER*: 800 MHz]	Set the center frequency to 800 MHz.
[**AMPT**: 0 dBm]	Set the reference level to 0 dBm.
[**MEAS**]	Call the menu for the measurement functions.
[*OCCUPIED BANDWIDTH*]	Select measurement of the occupied bandwidth and open the submenu for configuring the measurement.
[% POWER BANDWIDTH: 99 **%**]	Select 99% for the bandwidth to be measured.
[*CHANNEL BANDWIDTH*: 21 **kHz**]	Enter the channel bandwidth of 21 kHz specified by PDC.
[*ADJUST SETTINGS*]	Optimize the measurement parameters for the specified channel bandwidth. Allow for a complete frequency sweep so that FSP can determine the total signal power.
[*ADJUST REF LVL*]	Adjust the reference level to the measured signal power.
[**TRACE**: *DETECTOR*: *DETECTOR MAX PEAK*]	PDC prescribes measurement of the occupied bandwidth using a peak detector. Therefore, switch on the peak detector instead of the RMS detector selected by *ADJUST SETTINGS*.

Measurement of Signal Amplitude Statistics

Digital modulated signals are similar to white noise within the transmit channel but are different in their amplitude distribution. In order to transmit the modulated signal without distortion all amplitudes of the signal have to be transmitted linearly, e. g. from the output power amplifier. Most critical are the peak amplitude values, of course.
Degradation in transmit quality caused by a transmitter two port network is dependent on the amplitude of the peak values as well as on their probability.
The probability of amplitude values can be measured with the APD function (Amplitude Probability Distribution). During a selectable measurement time all occurring amplitude values are assigned to an amplitude range. The number of amplitude values in the specific ranges is counted and the result is displayed as a histogram. Each bar of the histogram represents the percentage of measured amplitudes within the specific amplitude range.

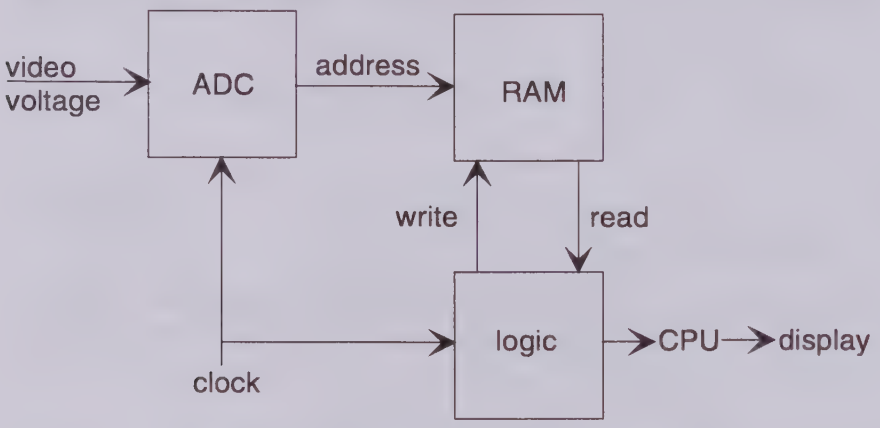


Fig. 4-9 Simplified block diagram for APD measurement

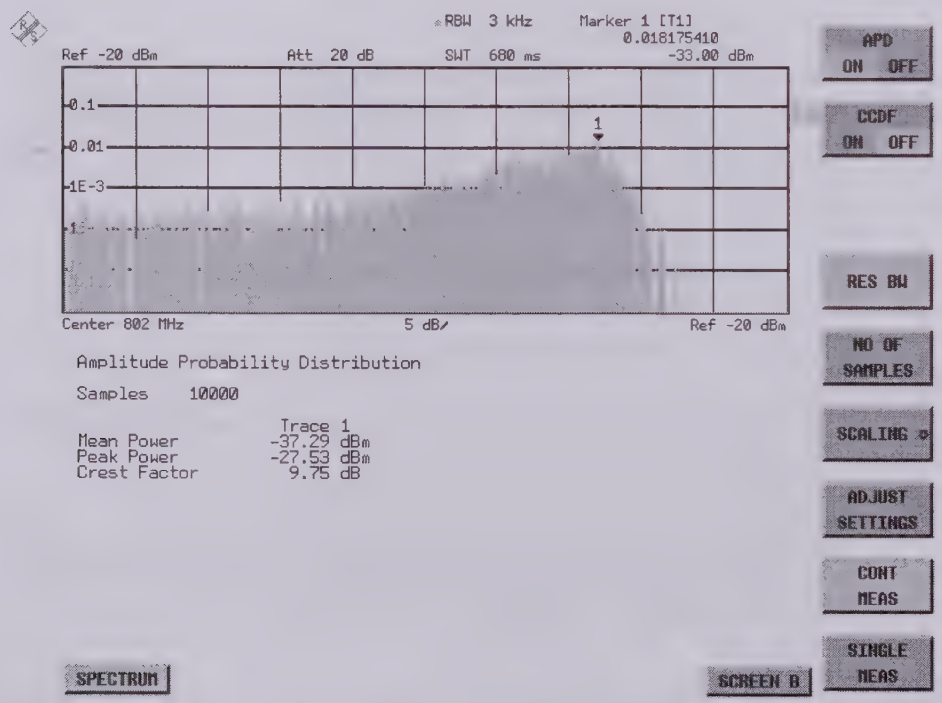


Fig. 4-10 Display of the amplitude probability distribution

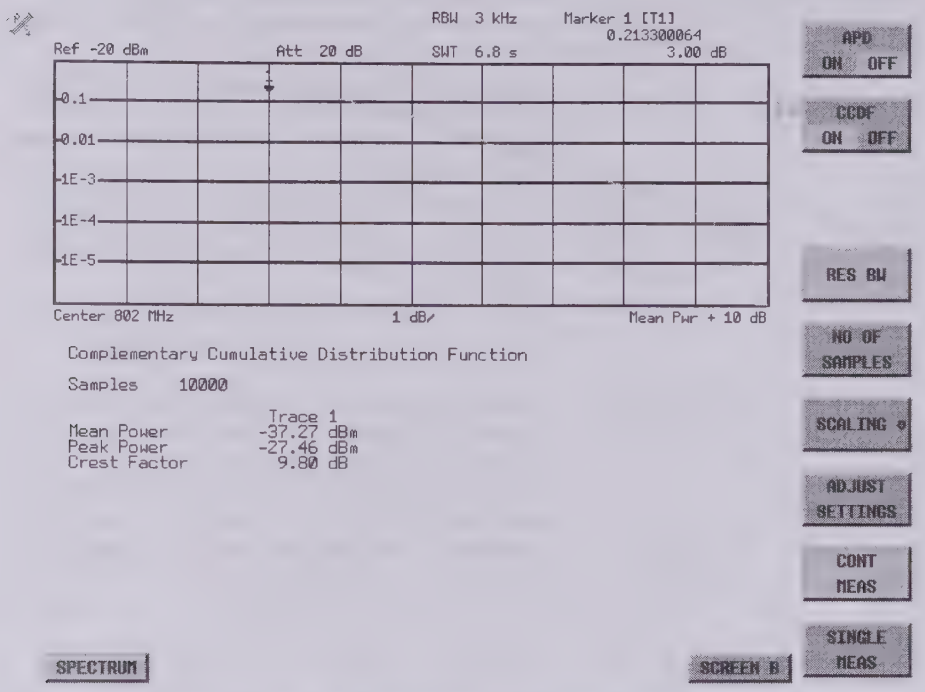


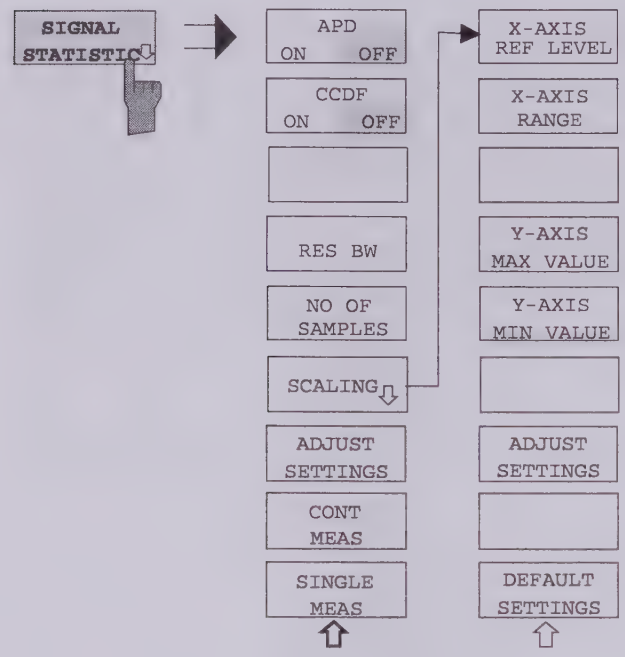
Fig. 4-11 Display of the complementary cumulative distribution function (CCDF)

Alternate to the histogram display of the APD the Complementary cumulative Distribution Function (CCDF) can be displayed. It shows the probability of an amplitude exceeding a specific value.
For the APD function the x-axis is scaled in absolute values in dBm, whereas for the CCDF function the x-axis is scaled relative to the MEAN POWER measured.

Definitions:
Crest Factor = Peak Voltage to rms
CCDF: Complementary cumulative Distribution Function

Note: *During an active statistic measurement the functions FULL SCREEN, SPLIT SCREEN and selection of the active diagram via SCREEN A / SCREEN B are disabled.*

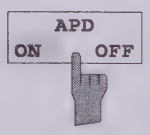
MEAS SIGNAL STATISTIC submenu :



The *SIGNAL STATISTIC* softkey opens a submenu for measurement of signal statistics.
In the submenu measurement of amplitude probability density (*APD*) and complementary cumulative distribution (*CCDF*) can be selected alternately. Only one of the signal statistic functions can be switched on at a time.

In default mode all statistic functions are switched off.
With a statistic function switched on the FSP is set into zero span mode automatically.

The FSP measures the statistics of the signal applied to the RF input with the resolution bandwidth set. In order not to influence the peak amplitudes the video bandwidth is automatically set to 10 times the resolution bandwidth. The sample detector is used for detecting the video voltage.

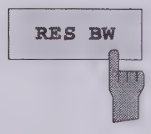


The *APD ON/OFF* softkey switches on or off the amplitude probability distribution function.
When the APD function is switched on, the CCDF function is switched off automatically.

IEC/IEEE-bus command: `CALC:STAT:APD ON`

The *CCDF ON/OFF* softkey switches on or off the complementary cumulative distribution function.
When the CCDF function is switched on, the APD function is switched off automatically.

IEC/IEEE-bus command: `CALC:STAT:CCDF ON`

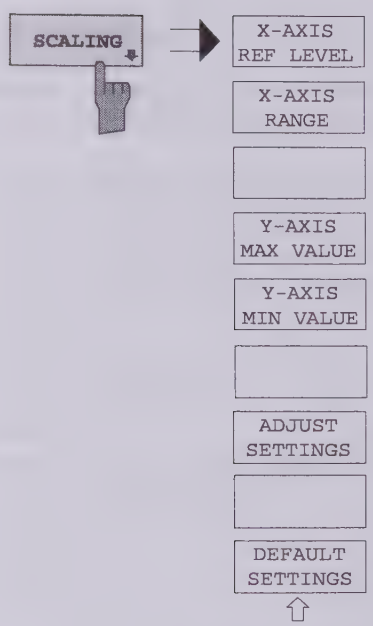


The *RES BW* softkey sets the resolution bandwidth in the menu *STATISTIC FUNCTION* directly without switching to the corresponding menu (BW). The function of the softkey is identical to the softkey *RES BW MANUAL* in the menu *BW*.
For correct measurement of the signal statistics the resolution bandwidth has to be wider than the signal bandwidth in order to transmit the actual peaks of the signal amplitude correctly. Video bandwidth is set to 10 MHz automatically with a statistic function switched on.

IEC/IEEE-bus command: `BAND 3 MHz`

The *NO OF SAMPLES* softkey sets the number of power measurements taken into account for the statistics.
Please note that the overall measurement time is influenced by the number of samples selected as well as by the resolution bandwidth set up for the measurement as the resolution bandwidth directly influences the sampling rate.

IEC/IEEE-bus command: `CALC:STAT:NSAM <value>`



The *SCALING* softkey opens a sub menu that allows changing the scaling parameters for both the x- and the y-axis.

The *X-AXIS REF LEVEL* softkey changes the level settings of the instrument and sets the maximum power to be measured.
The function is identical to softkey *REF LEVEL* in menu *AMPT*.
For the *APD* function this value is mapped to the right diagram border. For the *CCDF* function there is no direct representation of this value on the diagram as the x-axis is scaled relatively to the *MEAN POWER* measured.

IEC/IEEE command: `CALC:STAT:SCAL:X:RLEV <value>`

The *X-AXIS RANGE* softkey changes the level range to be covered by the statistics measurement selected.
The function is identical to softkey *RANGE LOG MANUAL* in menu *AMPT*.

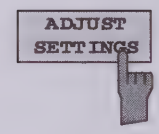
IEC/IEEE command: `CALC:STAT:SCAL:X:RANG <value>`

The *Y-AXIS MAX VALUE* softkey defines the upper limit of the displayed probability range.
Values on the y-axis are normalized which means that the maximum value is 1.0. As the y-axis scaling has a logarithmic axis the distance between max and min value must be at least one decade.

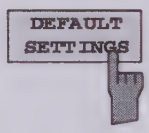
IEC/IEEE command: `CALC:STAT:SCAL:Y:UPP <value>`

The *Y-AXIS MIN VALUE* softkey defines the lower limit of the displayed probability range.
As the y-axis scaling has a logarithmic axis the distance between max and min value must be at least one decade. Valid values are in the range 0 < value < 1.

IEC/IEEE command: `CALC:STAT:SCAL:Y:LOW <value>`



see below



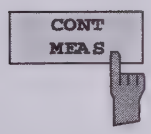
The *DEFAULT SETTINGS* softkey resets the x- and y-axis scalings to their PRESET values.

x-axis ref level:	-20 dBm
x-axis range APD:	100 dB
x-axis range CCDF:	20 dB
y-axis upper limit:	1.0
y-axis lower limit:	1E-6

IEC/IEEE-bus command: `CALC:STAT:PRES`

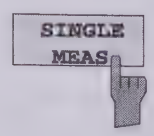
The *ADJUST SETTINGS* softkey optimizes the level settings of the FSP according to the measured peak power in order to gain maximum sensitivity of the instrument.
The level range is adjusted according to the measured difference between peak and minimum power for APD measurement and peak and mean power for CCDF measurement in order to obtain maximum power resolution.
Additionally the probability scale is adapted to the selected number of samples.

IEC/IEEE-bus command: `CALC:STAT:SCAL:AUTO ONCE`



The *CONT MEAS* softkey starts collecting a new sequence of sample data and calculating the APD or CCDF curve depending on the selected measurement. The next measurement is started automatically as soon as the indicated number of samples has been reached ("CONTinuous MEASurement").

IEC/IEEE-bus command:
```
INIT:CONT ON;
INIT:IMM
```



The *SINGLE MEAS* softkey starts collecting a new sequence of sample data and calculating the APD or CCDF curve depending on the selected measurement. At the beginning of the measurement previously obtained measurement results are discarded.

IEC/IEEE-bus command:
```
INIT:CONT OFF;
INIT:IMM
```

Hint for usage of the marker functions with measurement of signal statistics:

With the signal statistic measurement level always is displayed on x-axis. Y-axis always is a normalized value between 0 and 1. In contrary to use of marker in frequency or time domain marker is input in level values and the output is in percentage values.

Example:

Measurement of CCDF of a IS95 BTS signal, level 0 dBm, frequency 800 MHz

[**PRESET**]	Switch on preset settings.
[**FREQ**: *CENTER*: 800 MHz]	Set center frequency to 800 MHz.
[**AMPT**: 10 dBm]	Set reference level to 10 dBm.
[**BW**: 3 MHz]	Set resolution bandwidth to 3 MHz (resolution bandwidth shall be wider then signal bandwidth (1.25 MHz) in order to have the complete signal within the resolution bandwidth).
[**MEAS**]	Call up menu for measurement functions.
[*SIGNAL STATISTIC*]	Call up menu for signal statistics measurement.
[*CCDF ON /OFF*]	Switch on measurement of complementary cumulative distribution. The FSP switches to zero span mode. The power of the signal and the CCDF is calculated for the number of samples selected. With the CCDF function sample detector and video bandwidth are set automatically.
[NO OF SAMPLES: 10000]	Set the number of measurement samples to 10000.
[SINGLE MEAS]	Start the measurement sequence. At the end the resulting trace will display the CCDF for the measured 10000 samples.

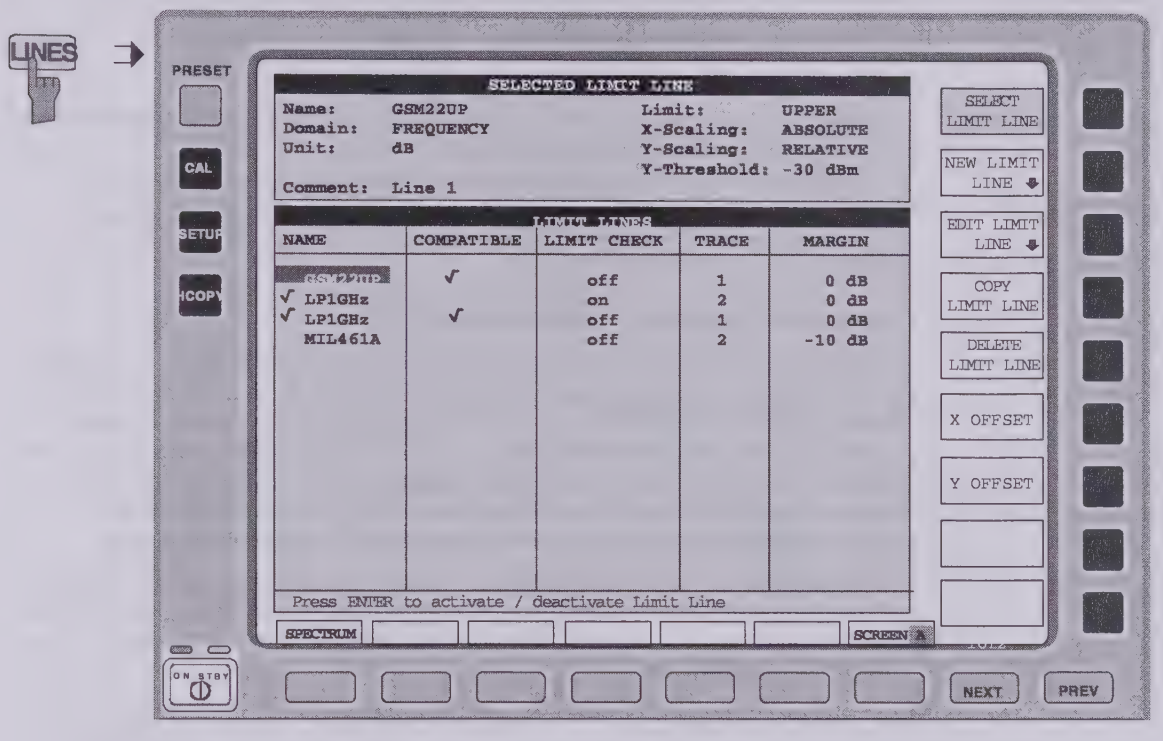
Setup of Limit Lines – *LINES* Key

Limit lines are used to define amplitude curves or spectral distribution boundaries on the display screen which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are permissible from a Unit Under Test (UUT). For transmission of information in TDMA (e.g., GSM), the amplitude of the bursts in a time slot must adhere to a curve which must fall within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).
The instrument supports limit lines with a maximum of 50 data points. 8 of the limit lines stored in the instrument can be used simultaneously and activated in the split-screen mode either in Screen A, Screen B or in the two windows. The number of limit lines stored in the instrument is only limited by the capacity of the flashdisk used.

For each limit line, the following characteristics must be defined:

- The name of the limit line. The limit line data are stored under this name and can be examined in the table *LIMIT LINES*.
- The domain in which the limit line is to be used. Here, a distinction is made between the time domain (span = 0 Hz) and the frequency domain (span > 0 Hz).
- The reference of the interpolation points to the X-axis. The limit line may be specified either for absolute frequencies or times or for frequencies which are related to the set center frequency and times related to the time on the left edge of the diagram.
- The reference of the interpolation points to the Y-axis. The limit line can be selected either for absolute levels or voltages or referred to the set maximum level (Ref Lvl). The position on the display depends on the REF LEVEL POSITION.
- With relative reference values for the Y axis, it is possible to enter an absolute threshold (THRESHOLD) which lowers the relative limit values (see below).
- The type of limit line (upper or lower limit). With this information and the active limit checking function (Table LIMIT LINES, column *LIMIT CHECK*), the FSP checks for compliance with each limit.
- The limit line units to be used. The units of the limit line must be compatible with the level axis in the active measurement window.
- The measurement curve (trace) to which the limit line is assigned. For the FSP, this defines the curve to which the limit is to be applied when several traces are simultaneously displayed.
- For each limit line, a margin can be defined which serves as a threshold for automatic evaluation.
- In addition, commentary can be written for each limit line, e.g., a description of the application.

LINES menu



The *LINES* key calls up the menu for setup of the limit lines.

The *SELECTED LIMIT LINE* display field provides information concerning the characteristics of the marked limit lines.

In the *LIMIT LINES* table, the limit lines compatible to the settings of the active screen can be enabled.

New limit lines can be specified and edited in the *NEW LIMIT LINE and EDIT LIMIT LINE* sub-menus, respectively.

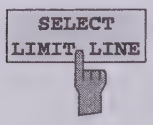
Limit Line Selection

LINES menu

The *SELECTED LIMIT LINES* table provides information about the characteristics of the marked limit line :

Name	name
Domain	frequency or time
Unit	vertical scale
Limit	upper/lower limit
X-Scaling	absolute or relative frequencies/times
Y-Scaling	absolute or relative Y-units
Threshold	absolute limit with relative Y-units
Comment	commentary

The characteristics of the limit line are set in the *EDIT LIMIT LINE (=NEW LIMIT LINE)* sub-menu.



The *SELECT LIMIT LINE* softkey activates the *LIMIT LINES* table and the selection bar jumps to the uppermost name in the table.

The following information is offered in the columns of the table:

Name	Enable the limit line.
Compatible	Indicates if the limit line is compatible with the measurement window of the given trace.
Limit Check	Activate automatic violation check for upper/lower limits.
Trace	Select the measurement curve to which the limit is assigned.
Margin	Define margin.

Name and Compatible - Enabling limit lines

A maximum of 8 limit lines can be enabled at any one time. In split screen mode, they may be assigned to screen A, screen B or to both screens. A check mark at the left edge of a cell indicates that this limit line is enabled.
A limit line can only be enabled when it has a check mark in the *Compatible* column, i.e., only when the horizontal display (time or frequency) and vertical scales are ***identical*** to those of the display in the measurement window.
Lines with the unit dB are compatible to all dB(..) settings of the Y-axis.

If the scale of the y-axis or the domain (frequency or time axis) are changed, all non-compatible limit lines are automatically switched off in order to avoid misinterpretation. The limit lines must be enabled anew when the original display is re-displayed.

IEC/IEEE-bus command:

```
CALC:LIM3:NAME "GSM1"
CALC:LIM3:UPP:STAT ON
CALC:LIM4:LOW:STAT ON
```

Limit Check - Activate automatic limit violation check

When *LIMIT CHECK ON* is activated, a GO/NOGO test is performed in the active screen. In the center of the diagram, a display window appears which indicates the results of the limit check test:

LIMIT CHECK: PASSED	No violations of active limits.
LIMIT CHECK: FAILED	One or more active limit lines were violated. The message contains the names of the limit lines which were violated or whose margins were not complied with.
LIMIT CHECK: MARGIN	The margin of at least one active limit lines was not complied with, however, no limit line was violated. The message contains the names of the limit lines whose margins were not complied with.

The following example shows two active limit lines:

```
LIMIT CHECK: FAILED

LINE VHF_MASK: Failed
LINE UHF2MASK: Margin
```

A check for violations of limit lines takes place only if the limit line of the assigned measurement curve (trace) is enabled.
If *LIM CHECK* is set to *OFF* for all active limit lines, then the limit line check is not executed and the display window is activated.

IEC/IEEE-bus command:

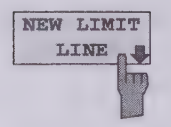
```
CALC:LIM:STAT ON
INIT;*WAI
CALC:LIM:FAIL?
```

***Trace* - Select the measurement curve to which the limit line is assigned.**

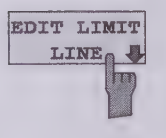
The selection of the measurement curve (trace) takes place in an entry window. Allowed are the integer entries 1, 2 or 3. The default setting is trace 1. If the selected limit line is not compatible with the assigned measurement curve, then the limit line is disabled (display and limit check).

IEC/IEEE-bus command:

```
CALC:LIM:TRAC 1
```



See following Section "Entry and Editing of Limit Lines".



The *COPY LIMIT LINE* softkey copies the data file describing the marked limit line and saves it under a new name. In this way, a new limit line can be easily generated by parallel translation or editing of an existing limit line. The name can be arbitrarily chosen and input via an entry window (max. of 8 characters).

IEC/IEEE-bus command:

```
CALC:LIM3:COPY 2          or
CALC:LIM3:COPY "GSM2"
```

The *DELETE LIMIT LINE* softkey erases the selected limit line. Before deletion, a message appears requesting confirmation.

IEC/IEEE-bus command:

```
CALC:LIM3:DEL
```

The *X OFFSET* softkey horizontally shifts a limit line, which has been specified for relative frequencies or times (X-axis). The softkey opens an entry window, where the value for shifting may be entered numerically or via the roll-key.

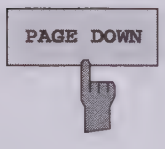
Note: *When changing the start or stop frequencies, the line on the display is only retained, if SPAN FIXED is set.*

IEC/IEEE-bus command: `CALC:LIM3:CONT:OFFS 10kHz`

The *Y OFFSET* softkey vertically shifts a limit line, which has relative values for the Y-axis (levels or linear units such as volt). The softkey opens an entry window where the value for shifting may be entered numerically or via the roll-key.

IEC/IEEE-bus command:
```
CALC:LIM3:LOW:OFFS 3dB
CALC:LIM3:UPP:OFFS 3dB
```

The *PAGE UP* softkey sets the limit line table to the next page.



The *PAGE DOWN* softkey sets the limit line table to the previous page.

Entry and Editing of Limit Lines

A limit line is characterized by

- its name
- the assignment of domain (frequency or time)
- the scaling in absolute or relative times or frequencies
- the vertical unit
- the vertical scaling
- the vertical threshold (only with relative vertical scaling)
- the margin
- the definition of the limit line as either upper or lower limit.
- the data points for frequency/time and level

At the time of entry, the FSP immediately checks that all limit lines are in accordance with certain guidelines. These guidelines must be observed if specified operation is to be guaranteed.

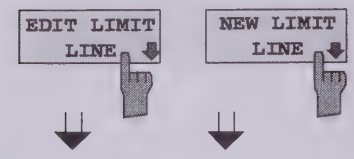
- The frequencies/times for each data point must be entered in ascending order, however, for any single frequency/time, two data points may be input (vertical segment of a limit line).

  The data points are allocated in order of ascending frequency/time. Gaps are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.

- The entered frequencies/times must not necessarily be selectable in FSP. A limit line may also exceed the specified frequency or time domains. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time domain representation, negative times may also be entered. The allowable range is -1000 s to +1000 s.

- The minimum/maximum value for a limit line is -200 dB to +200 dB for the logarithmic or 10^{-20} to 10^{+20} or -99.9% to + 999.9% for the linear amplitude scales.

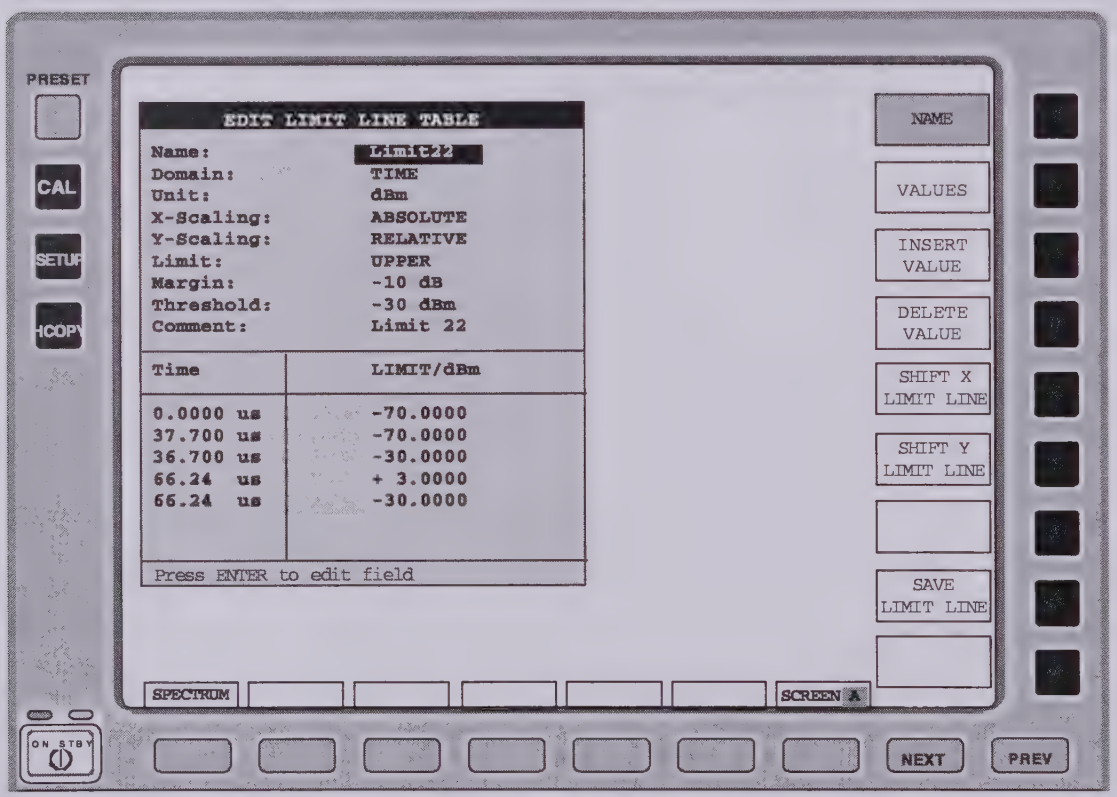
LINES - EDIT LIMIT LINE menu

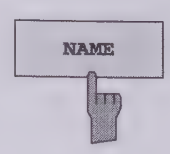


The *EDIT LIMIT LINE* and *NEW LIMIT LINE* softkeys both call the *EDIT LIMIT LINE* sub-menu used for editing limit lines. In the table heading, the characteristics of the limit line can be entered. The data points for frequency/time and level values are entered in the columns.

Name	Enter name.
Domain	Select domain.
Unit	Select units.
Limit	Select upper and lower limit value.
X-Scaling	Entry of absolute or relative values for the X-axis
Y-Scaling	Entry of absolute or relative values for the Y-axis
Margin	Entry of margin.
Threshold	Entry of vertical threshold (only with relative vertical scaling)
Comment	Enter comments.
Time/Frequency	Enter time/frequency for the data points.
Limit/dBm	Enter magnitudes for the data points.

Note: *Domain, unit, X scaling and Y scaling cannot be modified as soon as reference values have been entered in the data section of the table.*





The *NAME* softkey enables the entry of characteristics in the table heading.

***Name* - Enter name**

A maximum of 8 characters is permitted for each name. All names must be compatible with the MS DOS conventions for file names. The instrument stores all limit lines with the .LIM extension.

IEC/IEEE-bus command: `CALC:LIM3:NAME "GSM1"`

***Domain* - Select time or frequency domain**

The default setting is frequency.
A change in domain (frequency/time) is only permitted when the data point table is empty.

IEC/IEEE-bus command: `CALC:LIM3:CONT:DOM FREQ`

***Scaling* - selection of absolute or relative scaling**

The limit line can either be scaled in absolute (frequency or time) or relative units. Any of the unit keys may be used to toggle between *ABSOLUTE* and *RELATIVE*, the cursor must be positioned in the X-*Scaling* or the *Y-Scaling* line

X-Scaling ABSOLUTE The frequencies or times are interpreted as absolute physical units.

X-Scaling RELATIVE In the data point table, the frequencies are referred to the currently set center frequency. In time domain mode, the left boundary of the diagram constitutes the reference.

Y-Scaling ABSOLUTE The limit values refer to absolute levels or voltages.

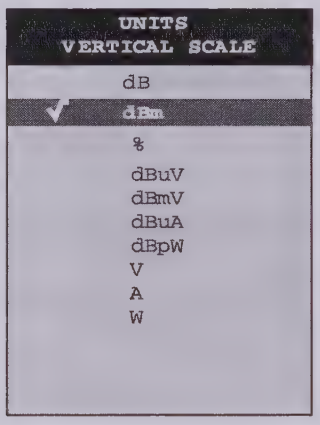
Y-Scaling RELATIVE The limit values refer to the reference level (Ref Level) or, in case a reference line is set, to the reference line.
Limit values with the unit dB are always relative values.

The *RELATIVE* scaling is always suitable, if masks for bursts are to be defined in the time domain, or if masks for modulated signals are required in the frequency domain.
An X-offset with half the sweep time may be entered in order to shift the mask in the time domain into the center of screen.

IEC/IEEE-bus command:
```
CALC:LIM3:CONT:MODE ABS
CALC:LIM3:UPP:MODE ABS
CALC:LIM3:LOW:MODE ABS
```

***Unit* - Select the vertical scale units for the limit line**

The selection of units takes place in a selection box. The default setting is dBm.



IEC/IEEE-bus command: `CALC:LIM3:UNIT DBM`

***Limit* - Select upper/lower limit**

A limit line can be defined as either an upper or lower limit.

IEC/IEEE-bus command: --
`(defined by key words :UPPer or :LOWer)`

***Margin* - Setting a margin.**

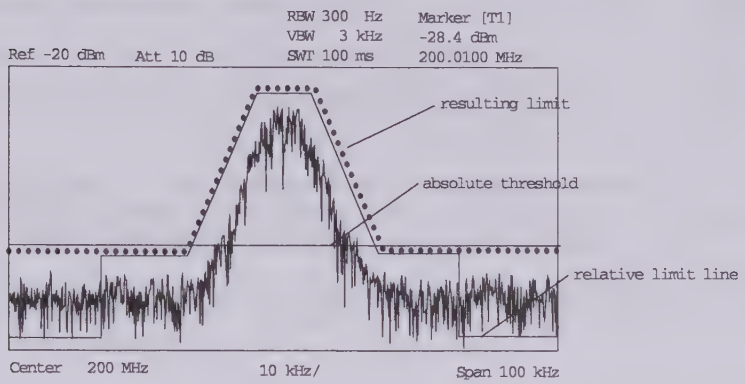
The margin is defined as the signal-level distance to the limit line . When the limit line is defined as an upper limit, the margin means that the level is below the limit line. When the limit line is defined as a lower limit, the margin means that the level is above the limit line. The default setting is 0 dB (i.e., no margin).

IEC/IEEE-bus command: `CALC:LIM3:UPP:MARG 10dB`
`CALC:LIM3:LOW:MARG 10dB`

***Threshold* – Selection of the threshold value with relative Y scaling**

With relative Y scaling, an absolute threshold value can be defined which lowers the relative limit values. The function is useful especially for mobile radio applications provided the limit values are defined in relatíon to the carrier power as long as they are above an absolute limit value.

Example:



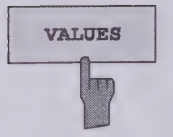
The preset value is at -200 dBm. The field is displayed if the value RELATIVE is entered in the field Y-SCALING.

IEC/IEEE-bus command:
```
CALC:LIM3:UPP:THR -30 dBm
or
CALC:LIM3:LOW:THR -30 dBm
```

***Comment* - Enter comments**

Comments are arbitrary, however, they must be less than 41 characters long.

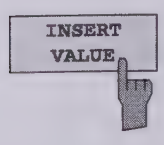
IEC/IEEE-bus command:
```
CALC:LIM3:COMM "Upper limit"
```



The *VALUES* softkey activates the entry of the data points in the table columns *Time/Frequency* and *Limit/dB*. Which table columns appear depends upon the *Domain* selection in the table heading.

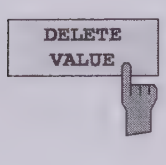
The desired frequency/time data points are entered in ascending order (two repeated frequencies/time values are permitted).

IEC/IEEE-bus command:
```
CALC:LIM3:CONT:DATA 1MHz,3MHz,30MHz
CALC:LIM3:UPP:DATA -10,0,0
CALC:LIM3:LOW:DATA -30,-40,-40
```



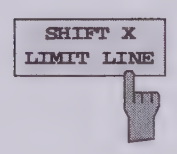
The *INSERT VALUE* softkey creates an empty line above the current cursor position where a new data point may be entered. However, during the entry of new values, it is necessary to observe an ascending order for frequency/time.

IEC/IEEE-bus command: `--`



The *DELETE VALUE* softkey erases the data point (complete line) at the cursor position. All succeeding data points are shifted down accordingly.

IEC/IEEE-bus command: --



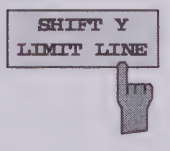
The *SHIFT X LIMIT LINE* softkey calls an entry window where the complete limit line may be shifted parallel in the horizontal direction.

The shift takes place according to the horizontal scale:

- in the frequency domain in Hz, kHz, MHz or GHz
- in the time domain in ns, µs, ms or s

In this manner, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally and stored (*SAVE LIMIT LINE* softkey) under a new name (*NAME* softkey).

IEC/IEEE-bus command: `CALC:LIM3:CONT:SHIF 50KHz`



The *SHIFT Y LIMIT LINE* softkey calls an entry window where the complete limit line may be shifted parallel in the vertical direction.

The shift takes place according to the vertical scale:

- for logarithmic units, relative, in dB
- for linear units, as a factor

In this manner, a new limit line can be easily generated based upon an existing limit line which has been shifted vertically and stored (*SAVE LIMIT LINE* softkey) under a new name (*NAME* softkey).

IEC/IEEE-bus command:
```
CALC:LIM3:CONT:UPP:SHIF 20dB
CALC:LIM3:CONT:LOW:SHIF 20dB
```

The *SAVE LIMIT LINE* softkey stores the currently edited limit line . The name can be entered in an input window (max. 8 characters)

IEC/IEEE-bus command: --

The *PAGE UP* softkey displays the next page of data points.

The *PAGE DOWN* softkey displays the previous page of data points.

Configuration of Screen Display – *DISP* Key

The *DISPLAY* menu allows the configuration of diagram display on the screen and also the selection of the display elements and colours. The *POWER SAVE* mode is also configured in this menu for the display.

The test results are displayed on the screen of the FSP either in a full-screen window or in two overlapping windows. The two windows are called diagram A and diagram B.

In the default setting, the two windows are completely decoupled from each other, ie they behave like two separate instruments. This is very useful, for example with harmonics measurements or measurements on frequency-converting DUTs, since the input signal and the output signal lie in different frequency ranges.

However, specific settings of the two windows (reference level, center frequency) can be coupled, if required, so that with *CENTER B = MARKER A* for example, the shift of the marker in diagram A causes the frequency range (zoomed in some cases) to be shifted along diagram B.

New settings which has been selected via hotkey *DIAG A* or *DIAG B* are performed in the diagram. If only one window is displayed, it is the diagram in which the measurements are performed; the diagram not displayed is not active for measurements.

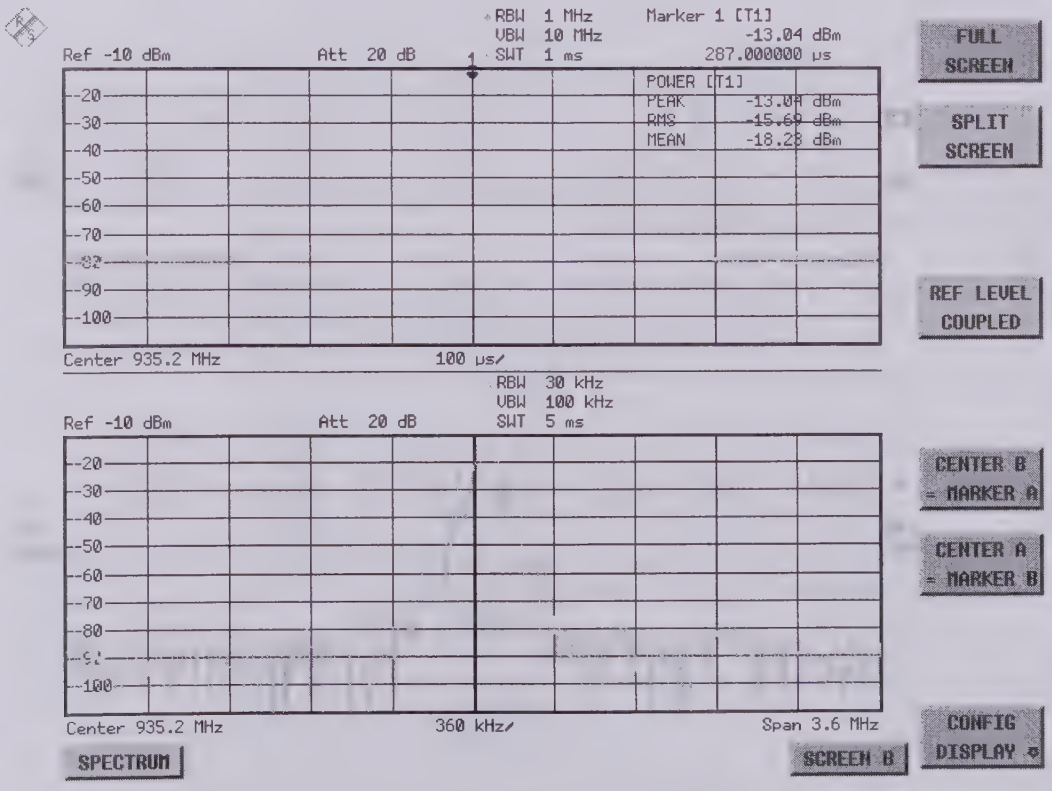
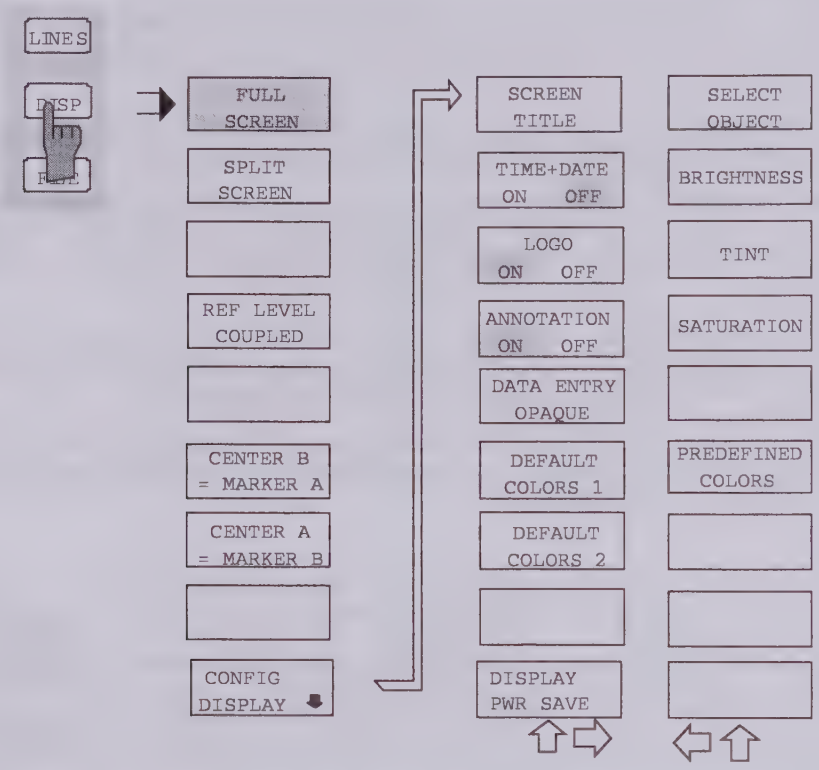
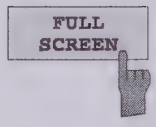


Fig. 4-12 Typical split-screen display, settings are uncoupled

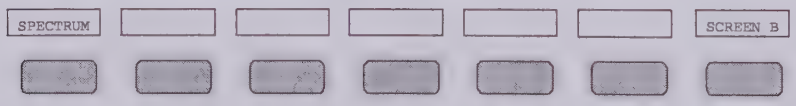
The *DISPL* key opens the menu for configuring the screen display and selecting the active diagram in SPLIT SCREEN mode.





The *FULL SCREEN* softkey selects display of one diagram. This corresponds to the default setting of FSP.

In the *FULL SCREEN* mode it is possible to switch between two different device settings by selecting the active window (screen A or screen B). Switching between *SCREEN A* and *SCREEN B* is performed by means of the corresponding key in the *HOTKEY bar*.



It should be noted that the measurements in the FULL SCREEN mode are performed only in the visible (active) window.

The active window is marked by **A** or **B** on the right of the diagram.

IEC/IEEE-bus command:
```
DISP:FORM SING
DISP:WIND<1|2>:SEL
```

The *SPLIT SCREEN* softkey selects display of two diagrams. The upper diagram is designated *SCREEN A*, the lower diagram *SCREEN B*.

Switching between *SCREEN A* and *SCREEN B* is performed via the corresponding key in the *HOTKEY* bar as with the *FULL SCREEN* softkey.

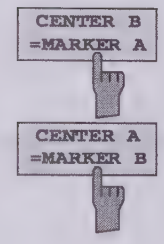
The active window is marked by highlighting fields **A** and **B** on the right of the diagram.

IEC/IEEE-bus command:
```
DISP:FORM SPL
```

The *REF LEVEL COUPLED* softkey switches the coupling of the reference level on and off. In addition to the reference level, the mixer level and input attenuation are coupled with one another.

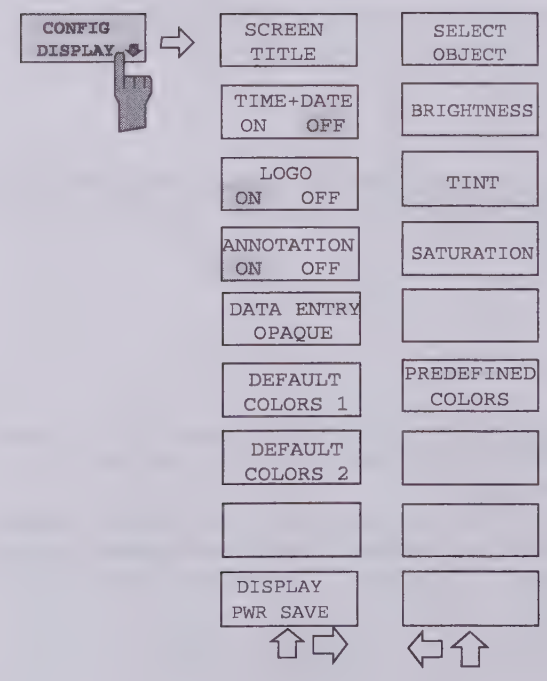
For the level measurement, the same reference level and input attenuation must be set for the two diagrams.

IEC/IEEE-bus command `INST:COUP RLEV`



The *CENTER B = MARKER A and CENTER A = MARKER B* softkeys couple the center frequency in diagram B with the frequency of marker 1 in diagram A and the center frequency in diagram B with the frequency of marker 1 in diagram B. The two softkeys are mutually exclusive.
This coupling is useful, eg for viewing the signal at the marker position in diagram A with higher frequency resolution or in the time domain in diagram B.
If marker 1 is off, it is switched on and set to the maximum of the trace in the active diagram.

IEC/IEEE-bus command:
```
INST:COUP CF_B
INST:COUP CF_A
```



The *CONFIG DISPLAY* softkey opens a submenu allowing additional displays to be superimposed on the screen. In addition, the display power-save mode (*DISPLAY PWR SAVE*) and the colours of the display elements can be set here.

The *SCREEN TITLE* softkey activates the entry of a title for the active diagram A or B. It switches on or off a title that is already input. The length of the title is limited to max. 20 characters.

IEC/IEEE-bus command:
```
DISP:WIND1:TEXT 'Noise Meas'
DISP:WIND1:TEXT:STATe ON
```

The *TIME+DATE ON/OFF* softkey switches on or off the display of date and time above the diagram.

IEC/IEEE-bus command:
```
DISP:TIME OFF
```

The *LOGO ON/OFF* softkey switches the Rohde & Schwarz company logo displayed in the upper left corner of the display screen on or off.

IEC/IEEE-bus command:
```
DISP:LOGO ON
```

The *ANNOTATION ON/OFF* softkey switches the displaying of frequency information on the screen on and off.

ON Frequency information is displayed.

OFF Frequency information is not outputted to the display. This can be used for example to protect confidential data.

IEC/IEEE-bus command:
```
DISP:ANN:FREQ ON
```

The *DATAENTRY OPAQUE* softkey sets the data entry windows to opaque. This means that entry windows are underlayed with the background colour for tables.

IEC/IEEE-bus command:
```
--
```

The *DEFAULT COLORS 1 and 2* softkey restores the default settings for brightness, colour tint and colour saturation for all display screen elements.
The colour schemes have been selected to give optimum visibility of all picture elements at an angle of vision from above or below. *DEFAULT COLORS 1* is active in the default setting of the instrument.

IEC/IEEE-bus command:
```
DISP:CMAP:DEF1
DISP:CMAP:DEF2
```

The *DISPLAY PWR SAVE* softkey is used to switch on/off the power-save mode for the display and to enter the time for the power-save circuit to respond. After the elapse of this time the display is completely switched off, ie including backlighting.

Note: *This mode is recommended for saving the TFT display especially when the instrument is exclusively operated in remote control.*

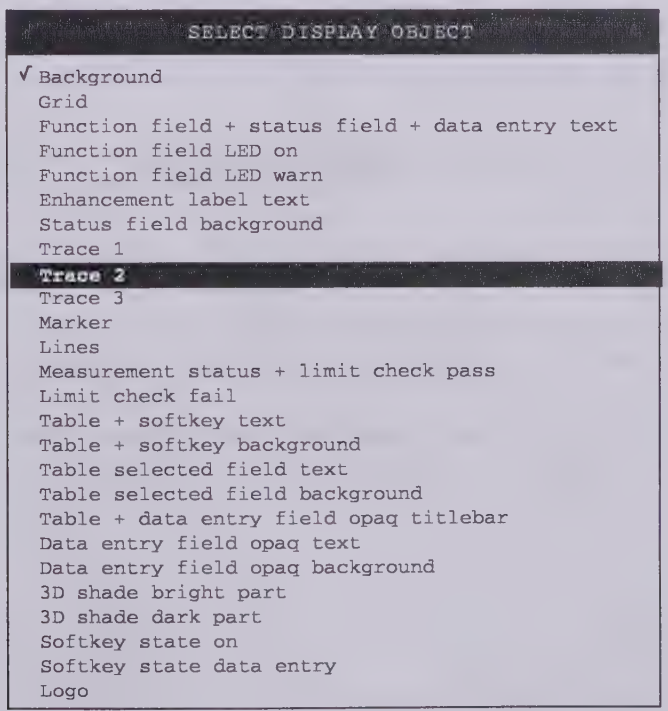
The power-save mode is configured as follows:

- The first keystroke activates the power-save mode and opens the editor for the response time (*POWER SAVE TIMEOUT*). The response time is entered in minutes between 1 and 6 minutes and is confirmed by *ENTER*.
- The power-save mode is deactivated by pressing the key again.

On leaving the menu with the power-save mode in the activated state, the softkey is highlighted in colour on returning to the menu and opens again the editor for the response time. Pressing again the key switches off the power-save mode.

IEC/IEEE-bus command: `DISP:PSAV ON`
`DISP:PSAV:HOLD 15`

The *SELECT OBJECT* softkey activates the *SELECT DISPLAY* OBJECT table, with which a graphics element can be selected. After selection, the brightness, tint and saturation of the selected element can be changed using the softkeys of the same name. The colour changes by means of the *PREDEFINED COLORS* softkey can be seen immediately on the display screen.



The *BRIGHTNESS* softkey activates entry of the brightness of the selected graphics element.

Values between 0 and 100% can be entered.

IEC/IEEE-bus: `DISP:CMAP3:HSL< hue>,<sat>,<lum>`

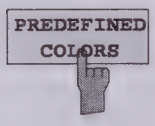
The *TINT* softkey activates the entry of the colour tint of the selected element. The entered value is related to a continuous colour spectrum ranging from red (0%) to blue (100%).

IEC/IEEE-bus: `DISP:CMAP3:HSL <hue>,<sat>,<lum>`

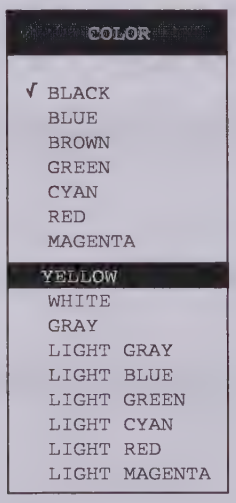
The *SATURATION* softkey activates the entry of the colour saturation for the selected element.

The range of inputs is from 0 to 100%.

IEC/IEEE-bus: `DISP:CMAP3:HSL <hue>,<sat>,<lum>`



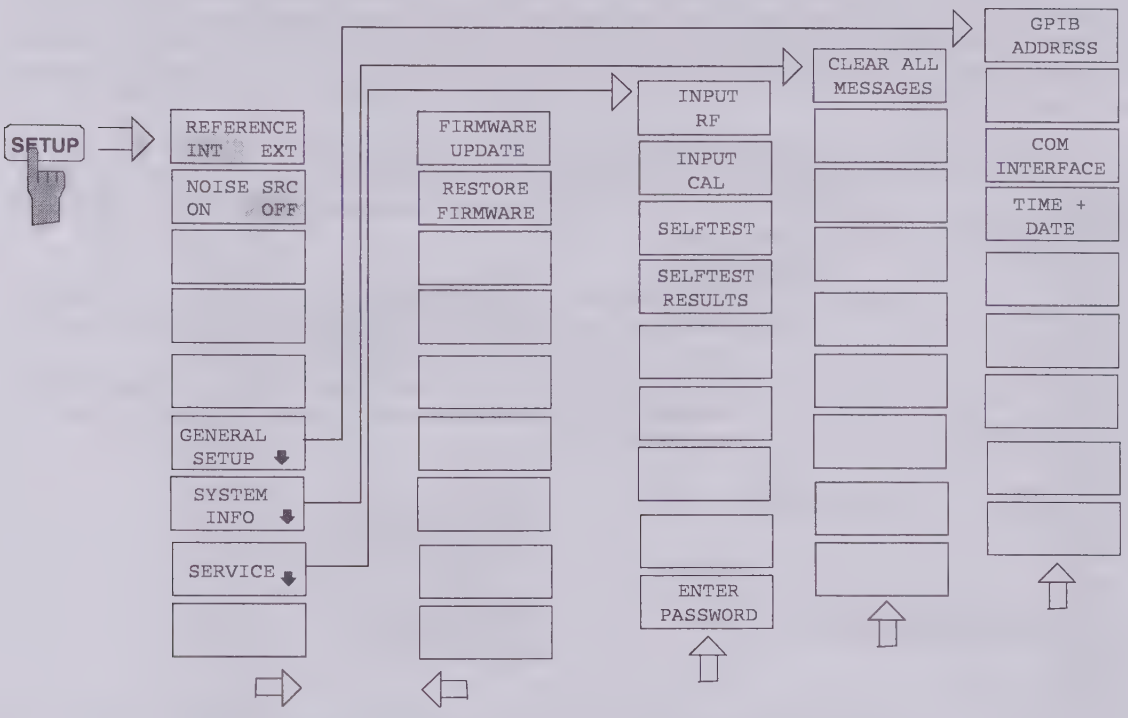
The *PREDEFINED COLORS* softkey activates a table, with which the predefined colours for the diplay screen elements can be selected.



IEC/IEEE-bus command: `DISP:CMAP1 to 26:PDEF <color>`

Preliminary Setup and Interface Configuration – *SETUP* Key

The *SETUP* key opens the menu for configuration of the FSP:



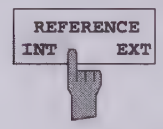
The following settings can be modified here:

- The *REFERENCE INT/EXT* softkey determines the source of the reference
- The *NOISE SRC ON/OFF* softkey switches on and off the voltage supply for an external noise source.
- The *GENERAL SETUP* softkey opens a submenu for all the general settings such as IEC/IEEE-bus address, date and time as well as the configuration of the device interfaces. *FIRMWARE OPTIONS* can be installed under this menu item.
- The *SYSTEM INFO* softkey opens a submenu for displaying the hardware configuration of the instrument, the switching cycle statistics and system messages.
- The *SERVICE* softkey opens a submenu in which special device functions and system information can be selected for servicing. The password required for service functions can be entered in this submenu.
- The *SERVICE FUNCTIONS* softkey enables additional special settings for servicing and troubleshooting. It is available after entering the corresponding password under the *SERVICE* softkey.

External Reference Oscillator

The FSP can use the internal reference source or an external reference source as frequency standard from which all internal oscillators can derived. A 10 MHz crystal oscillator is used as internal reference source. In the default setting (internal reference), this frequency is available as output signal at rear-panel connector REF OUT for example to synchronize other instruments to the reference of the FSP.
In the setting *REFERENCE EXT*, the connector REF IN is used as input connector for an external frequency standard. All internal oscillators of the FSP are synchronized to the external reference frequency (also 10 MHz).

SETUP menu:



The *REFERENCE INT / EXT* softkey switches between the internal and external references.

Note: *If the reference signal is missing on switching to external reference, the message "LOUNL" appears after a while to indicate that there is no synchronization.*
On switching to internal reference ensure that the external reference signal is de-activated to avoid interactions with the internal reference signal.

IEC/IEEE-bus command: `ROSC:SOUR INT`

External Noise Source

SETUP menu:

The *NOISE SRC ON/OFF* softkey switches on or off the supply voltage for an external noise source which is connected to the *NOISE SOURCE* connector on the instrument's rear panel.

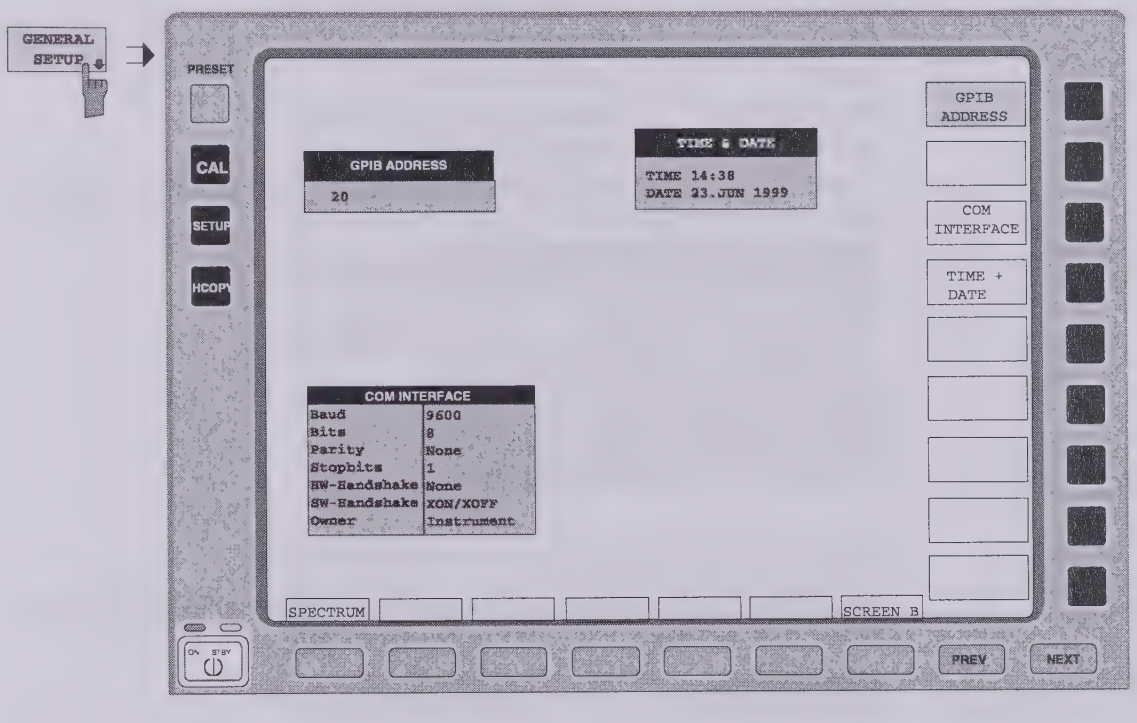
IEC/IEEE-bus command: `DIAG:SERV:NSO ON`

Programming the Interface Configuration and Time

The *GENERAL SETUP* softkey open a sub-menu in which the basic setup of general instrument parameters may be performed. In addition to the configuration of the digital interfaces (*IECBUS, COM*), the date and time may be entered.

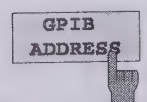
The current settings are displayed in tabular form on the display screen where they may then be edited.

*SETUP - GENERAL SETUP sub*menu:



IEC Bus Address Selection

SETUP - GENERAL SETUP submenu:



The *GPIB ADDRESS* softkey activates the entry of the IEC Bus address.

Permitted addresses are 0 through 30. The default setting is address 20.

IEC-Bus-Befehl: `SYST:COMM:GPIB:ADDR 20`

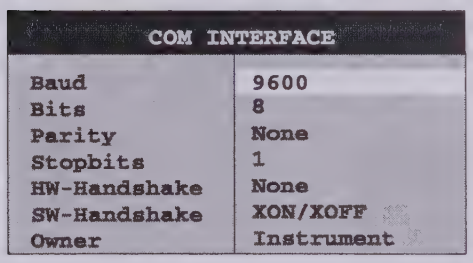
Serial Interface Configuration

SETUP-GENERAL SETUP submenu:

The *COM INTERFACE* softkey activates the *COM INTERFACE* table for entry of the serial interface parameters.

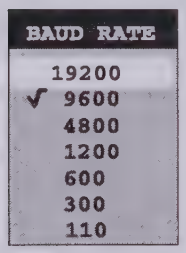
The following parameters need to be configured in the table:

Baud rate	data transmission rate
Bits	number of data bits
Parity	bit parity check
Stop bits	number of stop bits
HW-Handshake	hardware handshake protocol
SW-Handshake	software handshake protocol
Owner	assignment to the measuring instrument or computer



Baud – Data transmission rate

Allowed are the indicated values between 110 and 19200 baud. The default setting is 9600 baud.



IEC/IEEE-bus command: `SYST:COMM:SER:BAUD 9600`

Bits – Number of data bits per word

For the transmission of text without German umlauts (Ä, ä, Ü, ü, Ö, ö) and special characters, 7 bits are adequate. For binary data as well as text with special characters or umlauts, 8 bits must be selected (default setting).

IEC/IEEE-bus command: `SYST:COMM:SER:BITS 7`

***Parity* – Bit parity check**

NONE no parity check (default setting)
EVEN even parity check
ODD odd parity check

IEC/IEEE-bus command: `SYST:COMM:SER:PAR NONE`

***Stop bits* – Number of stop bits**

Available are 1 and 2. The default setting is 1 stop bit.

IEC/IEEE-bus command: `SYST:COMM:SER:SBIT 1`

***HW-Handshake* – Hardware handshake protocol**

The integrity of data transmission can be improved through the use of a hardware handshake protocol which effectively prevents uncontrolled transmission of data and the resulting possible loss of data bytes. In the hardware handshaking procedure, additional interface lines are used to transmit acknowledge signals with which the data transmission can be controlled and, if necessary, stopped until the receiver is ready to receive data again.

A prerequisite for handshaking is, however, that the interface lines (DTR and RTS) are provided between sender and receiver. For a simple, 3-wire connection, this is not the case and hardware handshake cannot be realized here.

Default setting is *NONE*.

IEC/IEEE-bus command:
```
SYST:COMM:SER:CONT:DTR OFF
SYST:COMM:SER:CONT:RTS OFF
```

***SW-Handshake* – Software handshake protocol**

Besides the hardware handshake procedure using interface lines, it is also possible to achieve the same effect by using a software handshake protocol. Here, control bytes are transmitted in addition to the normal data bytes. These control bytes can be used, as necessary, to stop data transmission until the receiver is ready to receive data again.

In contrast to hardware handshaking, software handshaking can be realized even for a simple, 3-wire connection.

One limitation is, however, present in software handshaking. Software handshaking cannot be used for the transmission of binary data since, the control characters XON and XOFF require bit combinations that are also used for binary data transmission.

Default setting is *NONE*.

IEC/IEEE-bus command: `SYST:COMM:SER:PACE NONE`

***Owner* – Assignment of the interface**

The serial interface can be assigned alternatively to the instrument measurement section or the computer section

If the interface is assigned to only one section of the instrument, it is not available to the other section.

INSTRUMENT — The interface is assigned to the instrument measurement section. Outputs to the interface from the computer are not possible and, so to say, land nowhere.

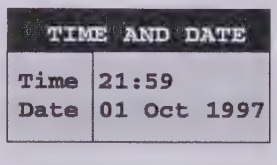
OS — The interface is assigned to the computer section. It cannot be used by the instrument measurement section. This means that remote control of the instrument via the interface is not possible.

IEC/IEEE-bus command: `--`

Setting Date and Time

SETUP-GENERAL SETUP submenu:

The *TIME+DATE* softkey activates the entry of time and date for the internal real time clock.



Time - Input of time

In the corresponding dialog box, the time is partitioned into two input fields so that hours and minutes can be entered independently.

IEC/IEEE-bus command: `SYST:TIME 21,59`

Date - Input of Date

In the corresponding dialog box, the date is partitioned into 3 input fields so that day, month and year can be input separately.

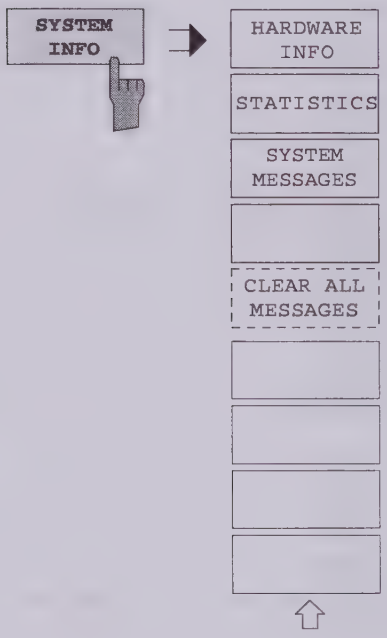
For the selection of the month, pressing a units key opens a list of abbreviations wherein the desired month can be selected.

IEC/IEEE-bus command: `SYST:DATE 1999,10,01`

System Information

The *SYSTEM INFO* softkey opens a submenu in which detailed information on module data, device statistics and system messages can be called up.

SETUP menu:



Display of Module Data

SETUP SYSTEM INFO submenu:

The *HARDWARE INFO* softkey opens two tables in which the modules (INSTALLED COMPONENTS) installed in the instrument are listed.

Table *HARDWARE INFOS* consists of six columns:

SERIAL #	serial number
COMPONENT	name of module
ORDER #	order number
MODEL	model number of the module
REV	main modification index of the module
SUB REV	secondary modification index of the module

HARDWARE INFO

COMPONENT	SERIAL #	ORDER #	MODEL	REV	SUB REV
Attenuator	123456/001	1234.5678	01	02	02
Frontend	234567/001	1234.5678	02	03	03
IF Filter	345678/001	1234.5678	03	04	04
Detector	456789/001	1234.5678	04	05	05
CPU	567890/001	1234.5678	05	04	04

Display of Device Statistics

SETUP SYSTEM INFO submenu:

The *STATISTICS* softkey opens the table *STATISTICS*. The table contains in addition to the model designation, serial number and firmware version, a list in which the operating time of the instrument, the power-on cycles as well as attenuator switching cycles are counted.

STATISTICS

Model	FSP3
Serial #	123456/789
Firmware Rev	1.23
BIOS Rev.	1.00
Operating time (hours)	375
Power On Cycles	786
Attenuator Cycles	
Input RF/Cal	57
10dB	1786
20dB	1473
40dB	675

IEC\IEEE-bus command: --

Display of System Messages

SETUP SYSTEM INFO submenu:

The *SYSTEM MESSAGES* softkey opens a submenu including a table in which the generated system messages are displayed. The most recent messages are at the top of the list.
The following information is presented:

No	Device specific three digit error code
MESSAGE	Brief description of the reason for the message
COMPONENT	Hardware messagesname of the affected module Software messages if needed, the name of the affected software components
DATE/TIME	Date and time of occurrence of the message

Messages that have occurred since the last call to the *SYSTEM MESSAGES* menu are marked with an asterix '*'.
The CLEAR ALL MESSAGES softkey is activated and allows clearing of the error memory.

If the number of error messages exceeds the capacity of the error memory, the message appearing first is "Message buffer overflow".

SYSTEM INFO

No	MESSAGE	COMPONENT	DATE/TIME
01	No of cycles	Attenuator	05.Jan.99 10:02:00
02	VCO unlock	Frontend	05.Jan.99 10:01:30
03	Calamp range	IF Filter	05.Jan.99 10:00:50
04	3.3V: Voltage	Detector	04.Jan.99 15:58:10
05	I2C-Bus failed	CPU	04.Jan.99 15:58:05

IEC\IEEE-bus command: `SYST:ERR?`

The *CLEAR ALL MESSAGES* softkey deletes all messages.
The softkey is only available when table *SYSTEM INFO* is active.

IEC\IEEE-bus command: `SYST:ERR?`

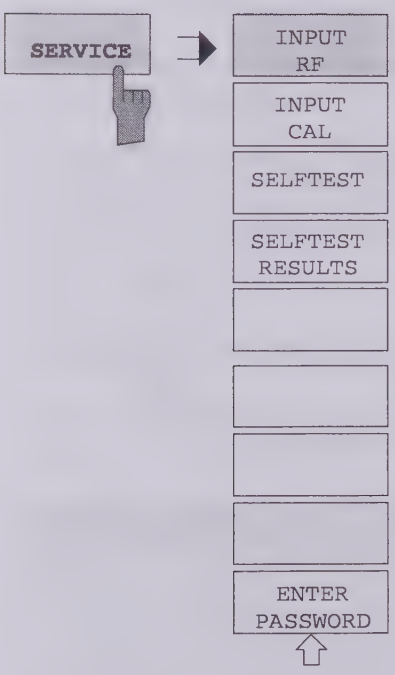
Service Menu

The service menu offers a variety of additional function which are used in maintenance and/or trouble shooting.

Caution:

The service functions are not necessary for normal measurements, however, incorrect use can impair the functionality and/or data integrity of the FSP. Therefore, many of the functions can only be used after entering a password. They are described in the servicel manual - instrument.

SETUP menu:

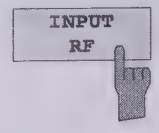


The *SERVICE* softkey open a submenu for selection of the service function.

The *INPUT RF* and *INPUT CAL* softkeys are mutually exclusive selection switches. Only one switch can be active at any one time.

General Service Functions

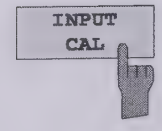
SETUP SERVICE submenu:



The *INPUT RF* softkey switches the input to the FSP to the input connector (normal position).

After *PRESET*, *RECALL* or FSP power on, the *INPUT RF* is always selected.

IEC-Bus-Befehle: `DIAG:SERV:INP RF`



The *INPUT CAL* softkey switches the input to the FSP to the internal calibration source (128 MHz) and activates the input of the output level of the calibration source. Possible values are 0 dB and -30 dB.

IEC-Bus-Befehl:
```
DIAG:SERV:INP CAL;
DIAG:SERV:INP:CSO 0 DBM
```

The *ENTER PASSWORD* softkey allows the entry of a password.

The FSP contains a variety of service functions which, if incorrectly used, can impair the functionality of the analyzer. These functions are normally not accessible and are only usable after the entry of a password (see service manual - instrument).

IEC/IEEE-bus command: `SYST:PASS "Password"`

Selftest

SETUP SERVICE submenu:

The *SELFTEST* softkey triggers the selftest of the instrument modules.

In case of failure the instrument can automatically locate a defective module.
During the selftest a message box appears in which the current test and the result is shown. The test sequence can be aborted by pressing ENTER ABORT.
All modules are checked consecutively and the test result (selftest PASSED or FAILED) is output in the message box.

IEC/IEEE-bus command: `*TST?`

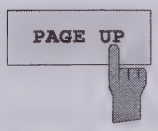
The *SELFTEST RESULTS* softkey calls the *SELFTEST* table in which the results of the module test are displayed.
In case of failure a short description of the failed test, the defective module, the associated value range and the corresponding test results are indicated.

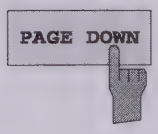
SELFTEST

SELFTEST: FAILED 24.APR.1999 14:25
Service level: 0

TEST	RESULT	VALID RANGE	VALUE
Voltages	OK		
Pretune DAC	OK		
Synthesizer	FAIL		
Frontend2 128MHz Ref unlock	FAIL	1.25V...3.5V	1.14V
Frontend1 384MHz Ref Input	OK	0.5...0.6V	0V
Signal Path	OK		

IEC/IEEE-bus command: `DIAG:SERV:STE:RES?`





The *PAGE UP* or *PAGE DOWN* sets the *SELFTEST RESULTS* table to the next or previous page.

IEC/IEEE-bus command --

Hardware Adjustment

Some of the FSP modules can be re-aligned. This re-alignment can become necessary after cablibration due to temperature drift or aging of components (see service manual instrument).

Caution:

The re-alignment should be carried out by qualified personnel since the any changes considerably influence the measurement accuracy of the instrument. This is the reason why the softkeys REF FREQUENCY, CAL SIGNAL POWER and SAVE CHANGES can only be accessed after entering a password.

Firmware Update

The installation of a new firmware version can be performed using the built-in diskette drive. The firmware update kit contains several diskettes.
The installation program is called up in the *SETUP* menu.

SETUP sidemenu:

The *FIRMWARE UPDATE* softkey starts the installation program and leads the user through the remaining steps of the update

IE/IEEE-bus command: --

Performing the update:

Insert diskette 1 into the drive.

Call *SETUP* side menu *[**SETUP**][**NEXT**]*

Start update *[FIRMWARE UPDATE]*

The *RESTORE FIRMWARE* softkey restores the previous firmware version

IEC/IEEE-bus command: --

Saving and Recalling Data Sets – *FILE* Key

The *FILE* key calls the following functions:

- Storage/loading functions for storing (*SAVE*) instrument settings such as instrument configurations (measurement/display settings, etc.) and measurement results from working memory to permanent storage media, or to load (*RECALL*) stored data into working memory.
- Functions for management of storage media (*FILE MANAGER*). Included are among others functions for listing files, formatting storage media, copying, and deleting/renaming files.

The FSP is capable of internally storing complete instrument settings with instrument configurations and measurement data in the form of data sets. The respective data are stored on the internal hard disk or, if selected, on a floppy. The hard-disk and floppy-disk drives have the following names:

floppy disk	A:
hard disk	D: (hard disk C: is reserved for instrument software)

In addition to the saving and recalling of complete instrument settings, it is also possible to save/recall subsets of settings. Configuration data and measurement values are stored in separate files. These files have the same name as the data set but however have a different extension. A data set thus consists of several files which have the same name but different extensions (see Table 4-2). Default setting for storing the data sets is directory D:\USER\CONFIG.

When saving or loading a data set, the subsets which are to be saved or loaded can be selected in the corresponding tables. This makes it easy to reconstruct specific instrument settings beside the default setting of the instrument.

When saving and loading data, data subsets are selected in table *SEL ITEMS TO SAVE/RECALL*.

The saved files of the data sets can be copied from one storage medium (e.g. drive C:) to another storage medium (e.g. drive A:) or to another directory using the functions found in the *FILE MANAGER* sub menu. File names and extensions must however not be changed. The relationship between the data subsets and the extensions is shown in Table 4-2.

Table 4-2 Relationship between extensions, contents and designations of data subsets

	Designation in the table SEL ITEMS TO SAVE/RECALL	**Contents**	**Extension**
Configuration data:	CURRENTSETTINGS	current settings of the measurement hardware and the related title, if present	.SET
		active limit lines	.LIN
		current configuration of general instrument parameters	.CFG
		configuration for hardcopy output	.HCS
Additional configuration data	ALL LIMIT LINES	all limit lines	.LIA
Measurement results:	ALL TRACES	measurement data trace 1 to trace 3, screen A	.TR1 to TR3
		measurement data trace 1 to trace 3, screen B	.TR4 to TR6

Saving a Data Set

- Select the data subsets to be saved (sub-menu *ITEMS TO SAVE/RCL* (configurations, measurement and calibration data) (softkey *ITEMS TO SAVE/RCL)* .
- Possibly enter a comment (softkey *EDIT COMMENT*)
- Enter the directory in which the data set should be saved in table *SAVE DATA SET* (softkey *SAVE*).
- Enter the name of the data set which should be saved (softkey *SAVE*) and save the data set by pressing the *ENTER* key.

  Data set names may contain both letters and numbers, in the simplest case only numbers.

  If required, the desired directory can be given a prefix to the data set name (the directory is then automatically set for further SAVE and RECALL operations).

  The simplest example for the input of a data set name is illustrated by the following key strokes:

  <SAVE> <1> <units key>

Note: *If the current instrument configuration is to be stored under an existing name, a selection list is available via the DATA SET LIST softkey. The storage is performed as follows.*

- *Press a units key after selecting a data set in table DATA SET LIST*

  The name and the selection of the data subsets for the currently selected data set will be placed in the SAVE DATA SET table.
- *Press the SAVE softkey.*

  The entry field EDIT NAME with the name of the selected data set is opened.
- *Press a units key.*
  The current instrument configuration is saved as a data set under this name.

Recalling a Data Set:

The data set can be loaded in two ways:

1. **Direct entry of the data name:**
   - Select data subsets which should be loaded (configurations, measurement and calibration data) with softkey *ITEMS TO SAVE/RCL* in sub menu *ITEMS TO SAVE/RCL).*
   - Enter the name of the data set to be saved (softkey *RECALL*) and recall the data set by pressing the *ENTER* key*).*

     Data set names may contain both letters and numbers, in the simplest case only numbers. If required, the desired directory can be prefixed to the data set name (the directory is then automatically set for further SAVE and RECALL operations).

     The simplest example for the input of a data set name is illustrated by the following key strokes: <RECALL> <1> <units key>

2. Selecting the data set from a selection list:

- Select from submenu *ITEMS TO SAVE/RCL* the data subsets which should be loaded (configurations, measurement and calibration data) (softkey *ITEMS TO SAVE/RCL).*
- Select the data set which should be loaded (Softkey *DATA SET LIST*) and confirm with *ENTER*. The data set is taken over in the *RECALL DATA SET* table.
- Press the RECALL softkey. The entry field for the data set name is opened and contains the desired data set.
- Initiate the loading of the selected data set by pressing the *ENTER* key.

Note: *If the set directory does not correspond to the required directory for loading, it can be changed as follows:*

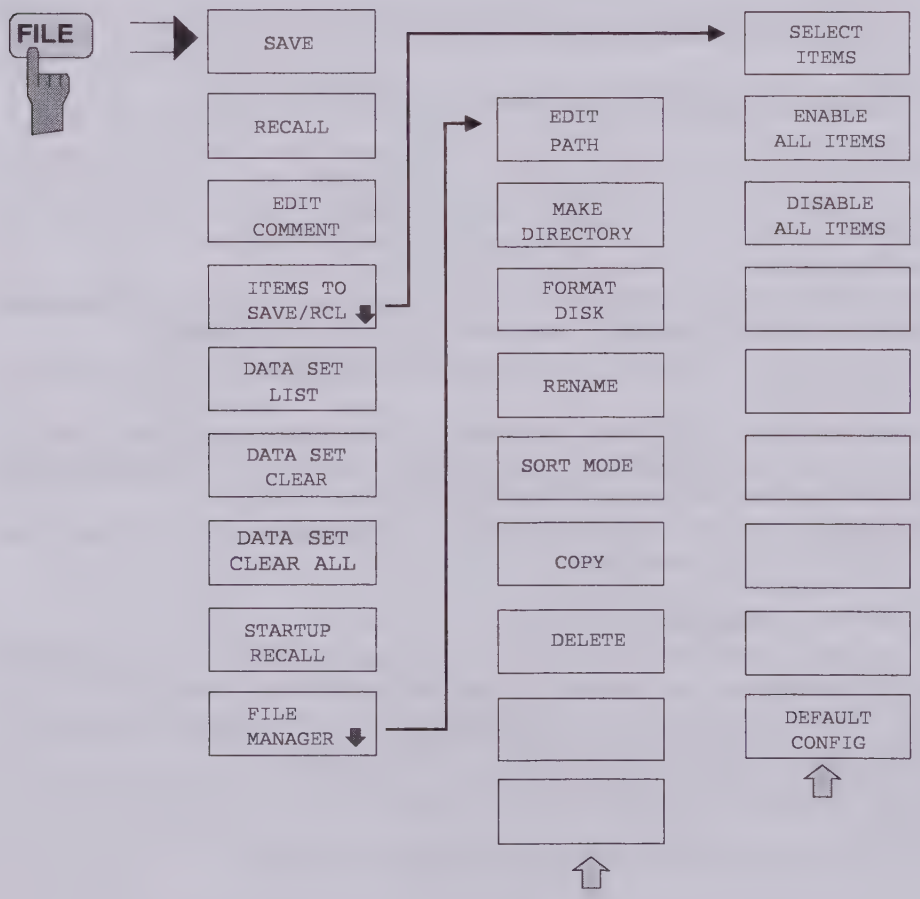
- *Press the RECALL softkey.*
- *Close the entry field for the data set name with ESC.*
- *Select the PATH filed with the cursor keys.*
- *Open the entry field for the directory name with ENTER.*
- *Enter the directory name and confirm with ENTER.*

Then proceed with the selection list as described above.

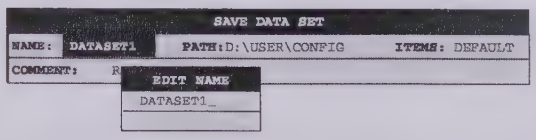
Any settings not restored when data subsets are loaded will remain unchanged in the instrument. During recall operations, the FSP recognises which subsets are present in the recalled data set and ignores selected data subsets that are not available.

FILE Menu

FILE menu



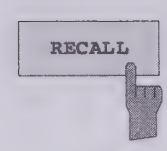
The *SAVE* softkey activates table *SAVE DATA SET*. The data set is stored by pressing the *ENTER* key.



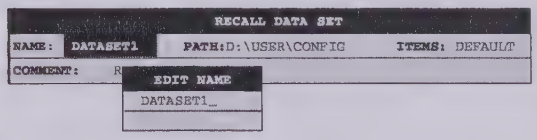
The *SAVE DATA SET* table contains the entry fields for editing the data set:

Name	name of data set The name can be entered with or without drive name and directory; the drive name and directory, if available, are then taken over in the PATH field. The extension of the data name is ignored.
Path	directory in which the data set will be saved
Items	indicates whether the default selection of the data subset (DEFAULT) or a user-defined selection (SELECTED) will be saved
Comment	Commentary regarding the data set

IEC/IEEE command: `MMEM:STOR:STAT 1,"a:\test02"`



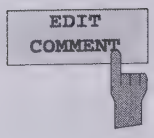
The *RECALL* softkey activates the entry of the path in which the data set is located. The data set is recalled by pressing the *ENTER* key.



The *RECALL DATA SET* table shows the current settings regarding the data set:

Name	name of data set
Path	directory in which the data set is located
Items	indicates whether the default selection of the data subset (DEFAULT) or a user-defined selection (SELECTED) will be recalled
Comment	Commentary regarding the data set

IEC/IEEE command: `MMEM:LOAD:STAT 1,"a:\test02"`

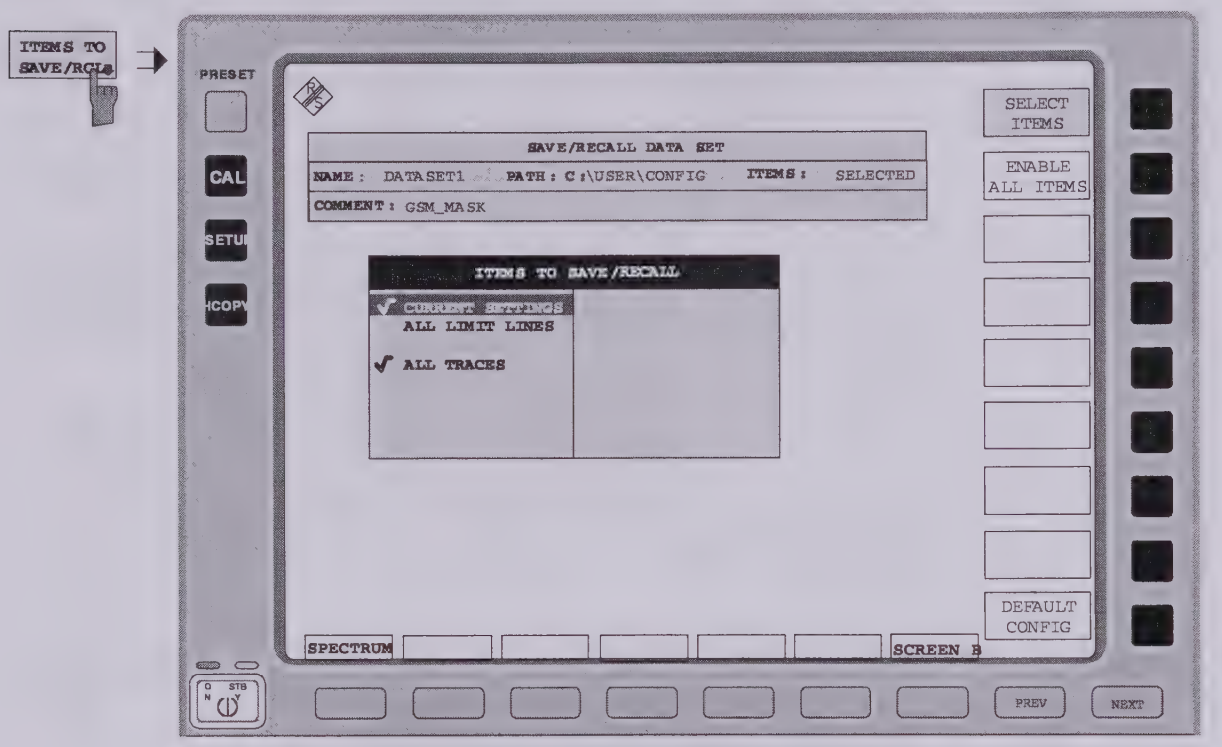


The *EDIT COMMENT* softkey activates the entry of commentary concerning the current data set. A total of 60 characters are available for this purpose.

IEC/IEEE command: `MMEM:COMM "Setup fuer GSM Messung"`

The *SEL ITEMS TO SAVE/RCL* softkey opens a sub-menu for selection of the data subsets.

FILE - ITEMS TO SAVE/RCL sub-menu:



The *ITEMS TO SAVE/RECALL* table offers the following selectable data subsets:

Current Settings these settings include:

- current configuration of general instrument parameters
- current measurement hardware settings
- active limit lines:
  A data set may contain maximum 8 limit lines for each window. It always contain the activated limit lines and the de-activated limit lines used last, if any.
  Consequently, the combination of the restored de-activated limit lines depends on the sequence of use with command `MMEM:LOAD`.
- user-defined color settings
- configuration for hardcopy output
- active transducer*All Limit Lines* all limit lines

All Traces all traces which are not blanked

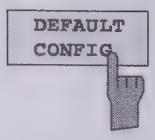
The *SELECT ITEMS* softkey moves the selection bar to the first line, left column of the table. An entry is selected by pressing the *ENTER* key in the desired line. The selection is cleared by pressing the key again.

IEC/IEEE command:

Current Settings:	`MMEM:SEL:HWS ON`
All Limit Lines:	`MMEM:SEL:LIN:ALL ON`
All Traces:	`MMEM:SEL:TRAC ON`

The *ENABLE ALL ITEMS* softkey marks all entries in the table.

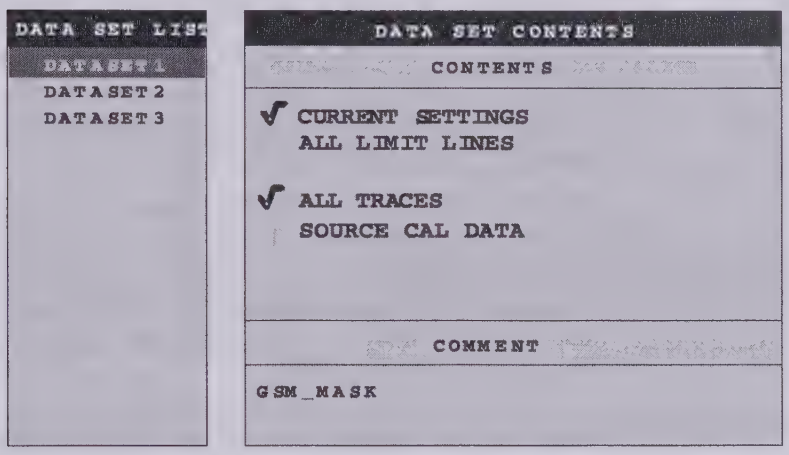
IEC/IEEE command: `MMEM:SEL:ALL`



The *DEFAULT CONFIG* softkey establishes the default selection of the data subset to be saved and outputs *DEFAULT* in the *ITEMS* field of the *SAVE/RECALL DATA SET* table.

IEC/IEEE command: `MMEM:SEL:DEF`

The *DATA SET LIST* softkey opens the *DATA SET LIST/CONTENTS* table. In addition, the *DATA SET CLEAR* and *DATA SET CLEAR ALL* softkeys are displayed.



The *DATA SET LIST* column lists all of the data sets which are stored in the selected directory.

The *CONTENTS* and *COMMENT* lines in the *DATA SET CONTENTS* column indicate the saved data subsets and the comment for the currently selected data set. A '-' prefixed to a data subset means that the latter is available in the instrument but that it has not been selected (see *SELECT ITEMS* softkey).

IEC/IEEE command:`MMEM:LOAD:AUTO 1,"D:\user\config\test02"`

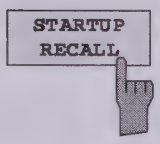
The *DATA SET CLEAR* softkey deletes the selected data set

IEC/IEEE command: `MMEM:CLE:STAT 1, "test03"`

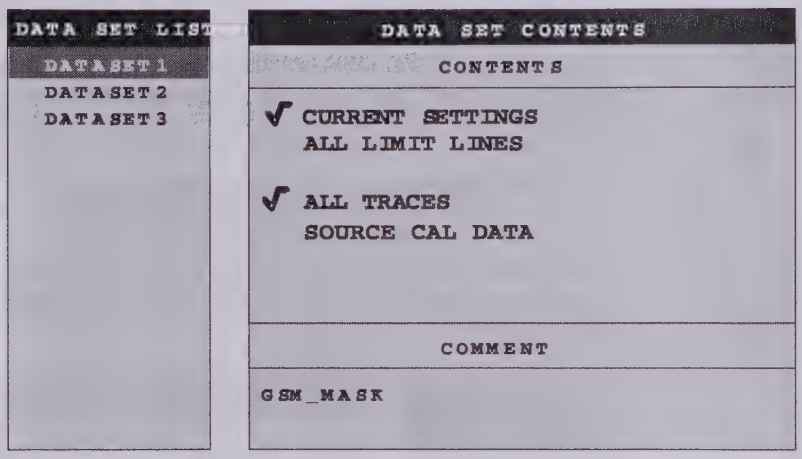
The *DATA SET CLEAR ALL* softkey deletes all data sets in the current directory.

Since, in this case, all available data sets are lost, confirmation by the user is required.

IEC/IEEE command: `MMEM:CLE:ALL`



The *STARTUP RECALL* softkey activates the selection of a data set which is automatically loaded when the instrument is powered on. To this end the table *DATA SET LIST/CONTENT* is opened (analog to *DATA SET LIST).*



The *DATA SET LIST* column displays all data sets present in the selected directory

The *CONTENTS* and *COMMENT* lines in the *STARTUP RECALL* column indicate the saved data subsets and the commentary for the currently selected data set.

In addition to the data sets stored by the user, the data set *FACTORY*, which specifies the settings of the instrument before it was last switched off (Standby), is always present.

If a data set other than *FACTORY* is chosen then, at the time of instrument power on, the available data subsets of the selected data set are recalled. The data subsets which are not present in this data set are taken from the *FACTORY* data set.

Note: *The specified data set is also loaded upon PRESET if STARTUP RECALL is active. The preset settiongs can thus be arbitrarily modified.*

IEC/IEEE command: `MMEM:LOAD:AUTO 1,"D:\user\config\test02"`

The *FILE MANAGER* softkey opens a menu for managing storage media and files.

FILE - FILE MANAGER sub-menu:

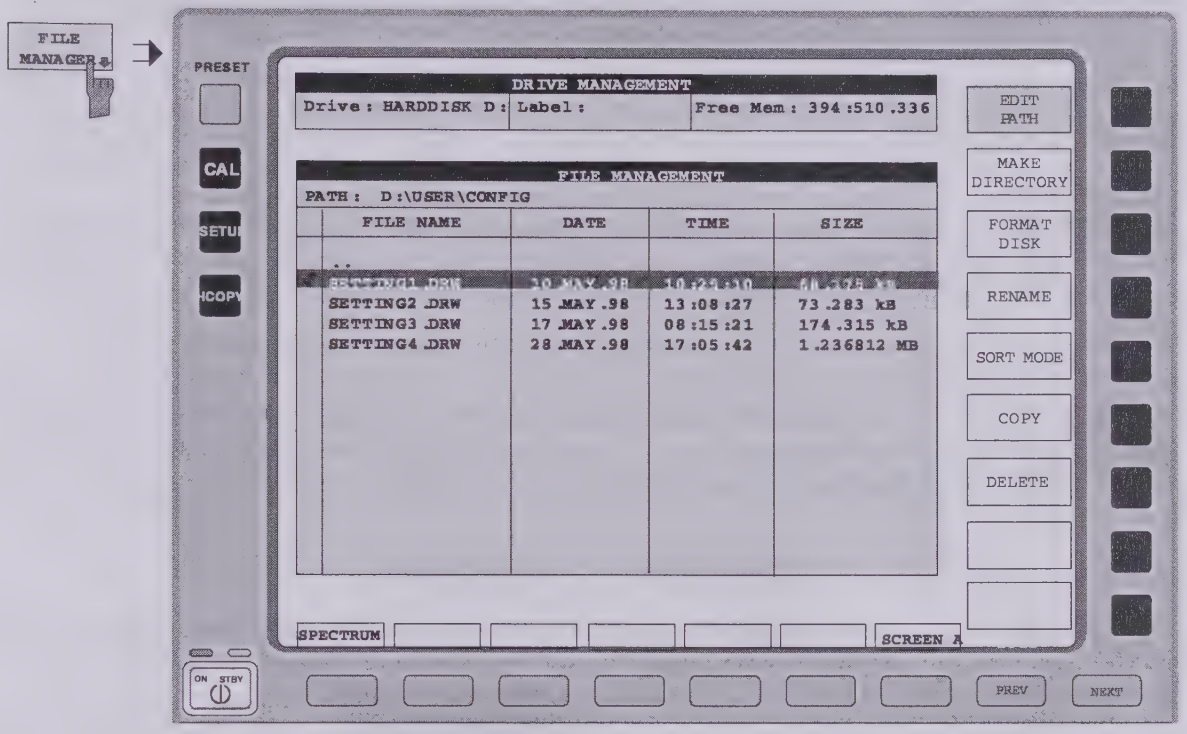


Table *Drive Management* displays the name and label of the storage medium as well as the available storage area.

Table *File Management* displays the files of the current directory and indicates if any subdirectories are present.

If a directory name is selected, the FSP automatically changes to this directory. Selection of the entry '..' moves the FSP to the next higher directory level..

Note: *It is not possible to change menus as long as a file operation is running.*

The *EDIT PATH* softkey activates the input of the directory which will be used in subsequent file operations.

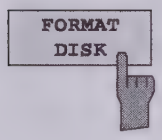
The new path is included in the *FILE MANAGEMENT* table.

IEC/IEEE command:
```
MMEM:MSIS "a:"
MMEM:CDIR "D:\user "
```

The *MAKE DIRECTORY* softkey creates directories/sub-directories. Sub-directories are recommended for sorting files on the storage medium so that the structure is easier to comprehend.

The entry of an absolute path name (e.g.; "\USER\MEAS") as well as the path relative to the current directory (e.g., "..\MEAS") is possible.

IEC/IEEE command: `MMEM:MDIR "D:\user\test"`

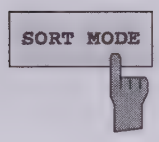


The *FORMAT DISK* softkey formats diskettes located in drive A:.
To prevent accidental destruction of diskette data, confirmation by the user is requested.

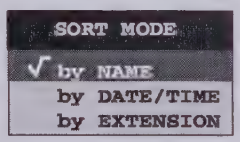
IEC/IEEE command: `MMEM:INIT "a:"`

The *RENAME* softkey activates the entry of a new name for the selected file or directory.

IEC/IEEE command: `MMEM:MOVE "test02.cfg","set2.cfg"`

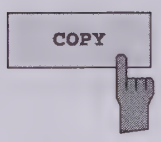


The *SORT MODE* softkey activates the selection of the criteria according to which the files listed in the *FILE MANAGEMENT* table may be sorted.



Directory names are located at the top of the list after the entry for the next higher directory level ("..").

IEC/IEEE command: `--`



The *COPY* softkey activates the input of the destination of the copy operation.

By entering a predefined disk drive (e.g. C:), a file can also be copied to another storage medium. The files/directories selected by the cursor are copied after the input is confirmed by pressing the *ENTER* key.

IEC/IEEE command: `MMEM:COPY "D:\user\set.cfg","a:"`

The *DELETE* softkey deletes the selected files.
To prevent accidental deletion of data, confirmation by the user is requested.

IEC/IEEE command:
```
MMEM:DEL "test01.hcp"
MMEM:RDIR "D:\user\test"
```

Measurement Documentation – *HCOPY* Key

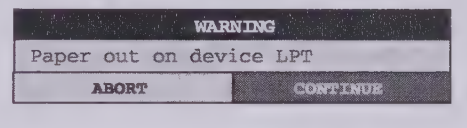
Note: *The installation of additional printers is described in Chapter 1, Section "Installation and Configuration of Printers".*

Pressing one of the softkeys *PRINT...* in the *HCOPY* menu initiates the print job. The printer parameters defined in the *DEVICE SETTINGS* menu are used for setting up the printer configuration. All of the display items to be printed are written to the printer buffer. Since the printer runs in the background, the instrument may be operated immediately after pressing the *PRINT...* softkey.

With *PRINT SCREEN* selected, all the diagrams with traces and status displays are printed as they occur on the screen. Softkeys, open tables and data entry fields are not printed out. Function *PRINT TRACE* allows printing out individual traces. With *PRINT TABLE* tables can be printed out.

If the *PRINT TO FILE* option in the *DEVICE SETTINGS* table is selected the printout is directed to a file. Upon pressing one of the softkeys *PRINT...*, the file name to which the output data are to be written is requested. For this an entry field is opened for entering the file name.

While a print job is in progress, problems may occur in the output device. If, while printing, the output device issues a PAPER OUT message, i.e., no more paper is available, the user will be prompted by the following message



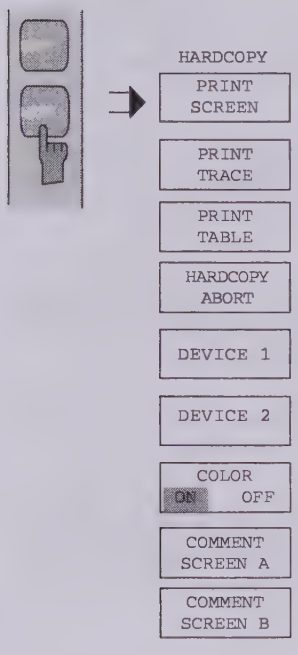
to load paper into the output device. The print job will then be either continued (CONTINUE selected) or aborted (ABORT selected).

Similar *SYSTEM MESSAGES* appear if the printer is offline, etc.

Switchover between b/w and colored printouts is possible with softkey *COLOR ON/OFF* provided that the printer connected is able to output such prints. The colors of the printout correspond exactly to those of the screen, i.e. a yellow trace will be output in yellow.
To change the colors of the objects on the printout, the screen colors have to be changed correspondingly in menu *DISPLAY*, submenu *CONFIG DISPLAY*. One exception is the color of the background and of the grid. The output background is always white irrespective of the screen color and the grid is always black.

The *HARDCOPY ABORT* softkey aborts a print job in progress.

HCOPY menu:



The *HCOPY* key opens the menu to define the output configuration and to start the printout.

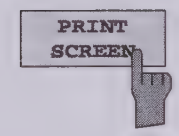
The instrument permits two different output devices to be configured. One of the devices is defined as the active device and can be used for hardcopies.

The *PRINT SCREEN, PRINT TRACE and PRINT TABLE* softkey start the printout of the selected item. The printout can be aborted by pressing the *HARDCOPY ABORT* softkey.

The *DEVICE1/2* softkeys call up a table for configuration of the selected output interface and determine the active device.

The *COLOR ON/ OFF* softkey switches between colored and b/w printouts.

A commentary applicable to the diagram can be added by using the *COMMENT SCREEN A* and *COMMENT SCREEN B* softkeys (date and time are added automatically).



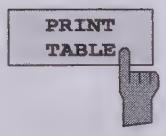
The *PRINT SCREEN* softkey starts the output of test results.

All the diagrams, traces, markers, marker lists, limit lines etc. are printed out as long as they are displayed on the screen. All the softkeys, tables and open data entry fields are not printed out. Moreover, comments, title, date, and time entered at the bottom margin of the printout are output.

IEC/IEEE-bus command:
```
HCOP:ITEM:ALL
HCOP:IMM
```

The *PRINT TRACE* softkey starts the output of all curves visible on the display screen without auxiliary information. Specifically, no markers or display lines are printed.

IEC/IEEE-bus command:
```
HCOP:ITEM:WIND:TRAC:STAT ON
HCOP:IMM
```

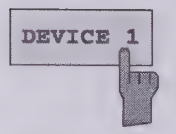


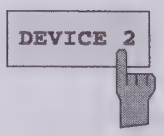
The *PRINT TABLE* softkey starts the output of all tables and info lists visible on the display screen without the measurement diagrams and inscriptions lying behind.

IEC/IEEE-bus command:
```
HCOP:ITEM:WIND:TABL:STAT ON
HCOP:IMM
```

The *HARDCOPY ABORT* softkey aborts the printout.

IEC/IEEE-bus command: ABOR





The *DEVICE 1/DEVICE 2* softkey determines the active output device. Table *HARDCOPY DEVICE SETTINGS* is simultaneously opened for the configuration of the two possible devices. The selection bar marks the selected line of the table.

HARDCOPY DEVICE SETTINGS	
Device1	WINDOWS METAFILE
Print to File	YES
Orientation	---
Device2	CLIPBOARD
Print to File	---
Orientation	---

Device 1/2 In this lines, the selection of the output device/language for Device1 or Device2 is made.

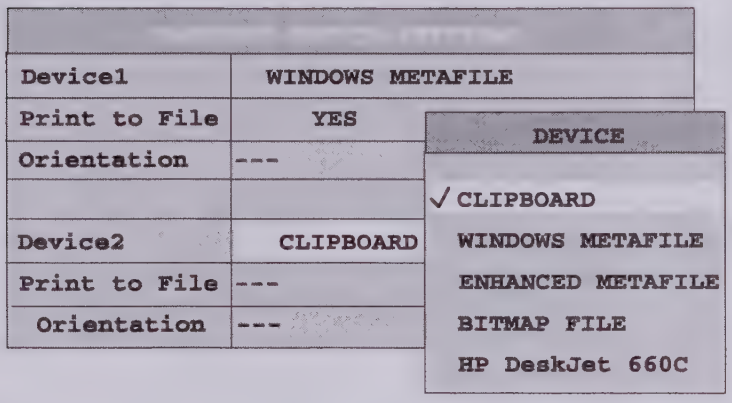
Print to File printout to file or printer

Orientation print format of the output page

Device 1/ Device 2

The selection of the output device/language for *Device 1* and *Device 2* is made in this line.
After pressing the *ENTER* key, the list of all installed printers is displayed. Three file formats and the Windows NT clipboard are also available:

CLIPBOARD	output in Windows NT clipboard.
WINDOWS METAFILE or BITMAP FILE	output in file
ENHANCED METAFILE	output in file or Windows NT clipboard.



The installation of additional printers is described in Chapter 1, Section "Installation and Configuration of Printers".

Notes: *Selecting the type of printer automatically sets the parameters PRINT TO FILE and ORIENTATION to values which correspond to a standard mode with this output device. Other printer-dependent parameters such as PAPERSIZE, can be modified under Windows NT in the printer properties window (START/SETTINGS/PRINTER/ SETTINGS). For operation of Windows NT, a mouse and an external keyboard have to be connected to instrument (see also Section "Installation and Configuration of Printers")*

IEC/IEEE-bus command:

```
HCOP:DEV:LANG GDI;
SYST:COMM:PRIN:ENUM:FIRS?;
SYST:COMM:PRIN:ENUM:NEXT?;
SYST:COMM:PRIN:SEL 'HP Deskjet 660 on LPT1';
HCOP:DEST "SYST:COMM:PRIN"
```

Print to File

In this line, directing the printout to the printer (OFF) or to a file (ON) is selected. For printout to a file, the user is prompted to enter a file name on starting the print.

Selecting the type of printer automatically sets this parameter to the value which correspond to a standard mode with this output device.

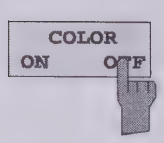
IEC/IEEE-bus command:

```
HCOP:DEST "SYST:COMM:PRIN" or
HCOP:DEST "SYST:COMM:MMEM"
```

Orientation

In this line, the print format of the output page is set to either vertical (= PORTRAIT) or horizontal (= LANDSCAPE).

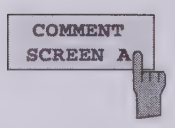
IEC/IEEE-bus command: `HCOP:PAGE:ORI PORT`

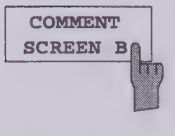


The *COLOR ON/ OFF* softkey selects a colored or b/w printout.

Colored background is printed white and colored lines are printed black in order to improve the contrast of the printout.
Default setting is *COLOR OFF*.

IEC/IEEE-bus command: `HCOP:DEV:COL ON`





The *COMMENT SCREEN A* or *B* soft key opens an entry field in which a comment of two lines (60 characters per line) can be entered to measurement window1 or 2.

If the user enters more than 60 characters, the excess characters appear on the second line on the print-out. At any point, a manual line-feed can be forced by entering the @ character.

The commentary is printed below the corresponding diagram. The comment text appears in the print-out, but does not appear on the display screen.

If a comment is not to appear on the printout, it has to be deleted.
By pressing *PRESET,* all comments will be deleted.

IEC/IEEE-bus command: `HCOP:ITEM:WIND2:TEXT 'Comment'`

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5 Remote Control - Basics

In this chapter you find:

- instructions how to put the FSP into operation via remote control,
- a general introduction to remote control of programmable instruments. This includes the description of the command structure and syntax according to the SCPI standard, the description of command execution and of the status registers,
- diagrams and tables describing the status registers used in the FSP.

In chapter 6, all remote control functions are described in detail. The subsystems are listed by alphabetical order according to SCPI. All commands and their parameters are listed by alphabetical order in the command list at the end of chapter 6.

Program examples for the FSP can be found in chapter 7.

The remote control interfaces and their interface functions are described in Chapter 8.

Introduction

The instrument is equipped with an IEC-bus interface according to standard IEC 625.1/IEEE 488.2 and a RS-232 interface. The connectors are located at the rear of the instrument and permits to connect a controller for remote control.

The instrument supports the SCPI:version 1997.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers (see Section "SCPI Introduction").
The tutorial "Automatic Measurement Control – A tutorial on SCPI and IEEE 488.2" from John M. Pieper (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

This section assumes basic knowledge of IEC/IEEE bus programming and operation of the controller. A description of the interface commands can be obtained from the relevant manuals.

The requirements of the SCPI standard placed on command syntax, error handling and configuration of the status registers are explained in detail in the following sections. Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

The program examples for IEC-bus programming are all written in VISUAL BASIC.

Getting Started

The short and simple operating sequence given below permits fast putting into operation of the instrument and setting of its basic functions. As a prerequisite, the IEC/IEEE-bus address, which is factory-set to 20, must not have been changed.

1. Connect instrument and controller using IEC/IEEE-bus cable.
2. Write and start the following program on the controller:

```
CALL IBFIND("DEV1", analyzer%)                  'Open port to the instrument
CALL IBPAD(analyzer%, 20)                       'Inform controller about instrument address
CALL IBWRT(analyzer%, '*RST;*CLS')              "Reset instrument

CALL IBWRT(analyzer%, 'FREQ:CENT 100MHz')       ' Set center frequency to 100 MHz
CALL IBWRT(analyzer%, 'FREQ:SPAN 10MHz')        ' Set span to 10 MHz
CALL IBWRT(analyzer%, 'DISP:TRAC:Y:RLEV -10dBm')
                                                ' Set reference level to -10 dBm
```

The instrument now performs a sweep in the frequency range of 95 MHz to 105 MHz.

3. To return to manual control, press the *LOCAL* key at the front panel

Switchover to Remote Control

On power-on, the instrument is always in the manual operating state ("LOCAL" state) and can be operated via the front panel.
It is switched to remote control ("REMOTE" state)

IEC/IEEE-bus as soon as it receives an addressed command from a controller.

RS-232 as soon as it receives the command "@REM" from a controller.

During remote control, operation via the front panel is disabled. The instrument remains in the remote state until it is reset to the manual state via the front panel or via remote control interfaces. Switching from manual operation to remote control and vice versa does not affect the remaining instrument settings.

Indications during Remote Control

During remote control, only the LOCAL softkey appears, with which it is possible to return to manual operation.

In addition, the display of diagrams and results can be blanked out with the command "`SYSTem:DISPlay:UPDate OFF`" (default in remote control) to obtain optimum performance during remote control operation.

During program execution it is recommended to activate the display of results by means of "`SYSTem:DISPlay:UPDate ON`" so that it is possible to follow the changes in the device settings and the recorded measurement curves on the screen.

Note: *If the instrument is exclusively operated in remote control, it is recommended to switch on the power-save mode (POWER SAVE). In this mode, the required display is completely switched off after a preset time.*

Remote Control via IEC/IEEE Bus

Setting the Device Address

In order to operate the instrument via the IEC-bus, it must be addressed using the set IEC/IEEE bus address. The IEC/IEEE bus address of the instrument is factory-set to 20. It can be changed manually in the *SETUP - GENERAL SETUP* menu or via IEC bus. Addresses 0 to 30 are permissible.

Manually:

- ➢ Call *SETUP - GENERAL SETUP* menu
- ➢ Enter desired address in table *GPIB-ADDRESS*
- ➢ Terminate input using the *ENTER* key

Via IEC/IEEE bus:

```
CALL IBFIND("DEV1", analyzer%)                    'Open port to the instrument
CALL IBPAD(analyzer%, 20)                         'Inform controller about old address
CALL IBWRT(analyzer%, "SYST:COMM:GPIB:ADDR 18") 'Set instrument to new address
CALL IBPAD(analyzer%, 18)                         'Inform controller about new address
```

Return to Manual Operation

Return to manual operation is possible via the front panel or the IEC/IEEE bus.

Manually: ➢ Press the *LOCAL* softkey or the *PRESET* key

Notes: – *Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.*

– *The keys can be disabled by the universal command LLO (see Chapter 8) in order to prevent unintentional switchover. In this case, switchover to manual mode is only possible via the IEC/IEEE bus.*

– *The keys can be enabled again by deactivating the REN line of the IEC/IEEE bus (see Chapter 8).*

Via IEC bus:

```
...
CALL IBLOC(analyzer%)                             'Set instrument to manual operation
...
```

Remote Control via RS-232-Interface

Setting the Transmission Parameters

To enable an error-free and correct data transmission, the parameters of the unit and the controller should have the same setting.
Parameters can be manually changed in menu *SETUP-GENERAL SETUP* in table *COM PORT* or via remote control using the command `SYSTem:COMMunicate:SERial:...`.

The transmission parameters of the COM interface are factory-set to the following values:
baudrate = 9600, data bits = 8, stop bits = 1, parity = NONE and owner = INSTRUMENT.
For remote control operation, the interface should be allocated to the operating system (owner = OS) so that the control characters including @ can be recognized by the interface.

Manually: Setting the COM interface

- ➢ Call *SETUP-GENERAL SETUP* menu
- ➢ Select desired baudrate, bits, stopbit, parity in table *COM PORT*.
- ➢ Set owner to OS in table *COM PORT*.
- ➢ Terminate input using the *ENTER* key.

Return to Manual Operation

Return to manual operation is possible via the front panel or via RS-232 interface.

Manually:

- ➢ Press the *LOCAL* softkey or the *PRESET* key.

Notes:

- *Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately*
- *The keys can be enabled again by sending the control string "@LOC" via RS-232 (see Chapter 8).*

Via RS-232:

```
...
v24puts(port,"@LOC");     Set instrument to manual operation..
...
```

Limitations

The following limitations apply if the unit is remote-controlled via the RS-232-C interface:

- No interface messages, only control strings.
- Only the Common Commands *OPC? can be used for command synchronization, *WAI and *OPC are not available.
- Block data cannot be transmitted.

Messages

The messages transferred via the data lines of the IEC bus can be divided into two groups:

- **interface messages and**
- **device messages.**

IEE/IEEE-Bus Interface Messages

Interface messages are transferred on the data lines of the IEC bus, the "ATN" control line being active. They are used for communication between controller and instrument and can only be sent by a controller which has the IEC/IEEE bus control. Interface commands can be subdivided into

- **universal commands and**
- **addressed commands.**

Universal commands act on all devices connected to the IEC/IEEE bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in chapter 8.

Device Messages (Commands and Device Responses)

Device messages are transferred on the data lines of the IEC bus, the "ATN" control line not being active. ASCII code is used.
A distinction is made according to the direction in which they are sent on the IEC/IEEE bus:

- **Commands** are messages the controller sends to the instrument. They operate the device functions and request informations.
  The commands are subdivided according to two criteria::

  1. According to the effect they have on the instrument:

     Setting commands cause instrument settings such as reset of the instrument or setting the center frequency.

     Queries cause data to be provided for output on the IEC/IEEE bus, e.g. for identification of the device or polling the marker.

  2. According to their definition in standard IEEE 488.2:

     Common Commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as management of the standar-dized status registers, reset and selftest.

     Device-specific commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standardized by the SCPI committee (cf. Section "SCPI Introduction")).

- **Device responses** are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status (cf. Section "Responses to Queries").

Structure and syntax of the device messages are described in the following Section.

Structure and Syntax of the Device Messages

SCPI Introduction

SCPI (Standard Commands for Programmable Instruments) describes a standard command set for programming instruments, irrespective of the type of instrument or manufacturer. The goal of the SCPI consortium is to standardize the device-specific commands to a large extent. For this purpose, a model was developed which defines the same functions inside a device or for different devices. Command systems were generated which are assigned to these functions. Thus it is possible to address the same functions with identical commands. The command systems are of a hierarchical structure.
Fig. 5-1 illustrates this tree structure using a section of command system SENSe, which controls the device-specific settings, that do not refer to the signal characteristics of the measurement signal.
SCPI is based on standard IEEE 488.2, i.e. it uses the same syntactic basic elements as well as the common commands defined in this standard. Part of the syntax of the device responses is defined with greater restrictions than in standard IEEE 488.2 (see Section "Responses to Queries").

Structure of a Command

The commands consist of a so-called header and, in most cases, one or more parameters. Header and parameter are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several key words. Queries are formed by directly appending a question mark to the header.

Note: *The commands used in the following examples are not in every case implemented in the instrument.*

Common commands

Common commands consist of a header preceded by an asterisk "*" and one or several parameters, if any.

Examples:

`*RST`	RESET, resets the device
`*ESE 253`	EVENT STATUS ENABLE, sets the bits of the event status enable register
`*ESR?`	EVENT STATUS QUERY, queries the contents of the event status register.

Device-specific commands

Hierarchy: Device-specific commands are of hierarchical structure (see Fig. 5-1). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system.

Example: `SENSe` This key word denotes the command system `SENSe`.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example: `SENSe:FREQuency:SPAN 10MHZ`

This command lies in the third level of the SENSe system. It set the frequency span.

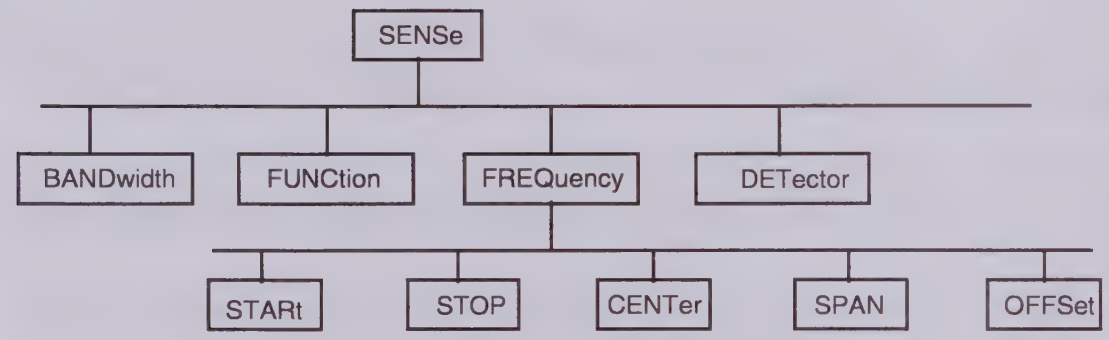

Fig. 5-1 Tree structure the SCPI command systems using the SENSe system by way of example

Some key words occur in several levels within one command system. Their effect depends on the structure of the command, that is to say, at which position in the header of a command they are inserted.

Example: `SOURce:FM:POLarity NORMal`
This command contains key word POLarity in the third command level. It defines the polarity between modulator and modulation signal.

`SOURce:FM:EXTernal:POLarity NORMal`
This command contains key word POLarity in the fourth command level. It defines the polarity between modulation voltage and the resulting direction of the modulation only for the external signal source indicated.

Optional key words: Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked by square brackets in the description. The full command length must be recognized by the instrument for reasons of compatibility with the SCPI standard. Some commands are considerably shortened by these optional key words.

Example: `[SENSe]:BANDwidth[:RESolution]:AUTO`
This command couples the resolution bandwidth of the instrument to other parameters. The following command has the same effect:
BANDwidth`:AUTO`

Note: *An optional key word must not be omitted if its effect is specified in detail by a numeric suffix.*

Long and short form: The key words feature a long form and a short form. Either the short form or the long form can be entered, other abbreviations are not permissible.

Beispiel: `STATus:QUEStionable:ENABle 1= STAT:QUES:ENAB 1`

Note: *The short form is marked by upper-case letters, the long form corresponds to the complete word. Upper-case and lower-case notation only serve the above purpose, the instrument itself does not make any difference between upper-case and lower-case letters.*

Parameter: The parameter must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma ",". A few queries permit the parameters MINimum, MAXimum and DEFault to be entered. For a description of the types of parameter, refer to Section "Parameters".

Example: `SENSe:FREQuency:STOP? MAXimum` Response: 3.5E9
This query requests the maximal value for the stop frequency.

Numeric suffix: If a device features several functions or features of the same kind, e.g. inputs, the desired function can be selected by a suffix added to the command. Entries without suffix are interpreted like entries with the suffix 1.

Example:. `SYSTem:COMMunicate:SERial2:BAUD 9600`
This command sets the baudrate of a second serial interface.

Structure of a Command Line

A command line may consist of one or several commands. It is terminated by a <New Line>, a <New Line> with EOI or an EOI together with the last data byte. The IEC/IEEE driver of the controller usually produces automatically an EOI together with the last data byte.

Several commands in a command line are separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:
```
CALL IBWRT(analyzer%,"SENSe:FREQuency:CENTer 100MHz;:INPut:ATTenuation 10")
```

This command line contains two commands. The first one is part of the SENSe command system and is used to determine the center frequency of the analyzer. The second one is part of the INPut command system and sets the input signal attenuation.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels (see also Fig. 5-1). The colon following the semicolon must be omitted in this case.

Example:
```
CALL IBWRT(analyzer%, "SENSe:FREQuency:STARt 1E6;:SENSe:FREQuency:STOP 1E9")
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the SENSe command system, subsystem FREQuency, i.e. they have two common levels.
When abbreviating the command line, the second command begins with the level below SENSe:FREQuency. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

```
CALL IBWRT(analyzer%,  "SENSe:FREQuency:STARt 1E6;STOP 1E9")
```

However, a new command line always begins with the complete path.

Example:
```
CALL IBWRT(analyzer,  "SENSe:FREQuency:STARt 1E6")
CALL IBWRT(analyzer%,  "SENSe:FREQuency:STOP 1E9")
```

Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

1 The requested parameter is transmitted without header.
Example: `INPut:COUPling?` Response: `DC`

2. Maximum values, minimum values and all further quantities, which are requested via a special text parameter are returned as numerical values.
Example: `SENSe:FREQuency:STOP? MAX` Response: `3.5E9`

3. Numerical values are output without a unit. Physical quantities are referred to the basic units or to the units set using the Unit command.
Example: `SENSe:FREQuency:CENTer?` Response: `1E6` for 1 MHz

4. Truth values <Boolean values> are returned as 0 (for OFF) and 1 (for ON).
Example: `SENSe:BANDwidth:AUTO?` Response: `1` for ON

5. Text (character data) is returned in a short form (see also Section 3.5.5).
Example: `SYSTem:COMMunicate:SERial:CONTrol:RTS?` Response(for standard): `STAN`

Parameters

Most commands require a parameter to be specified. The parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The type of parameter required for the respective command and the permissible range of values are specified in the command description

Numerical values

Numerical values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not permissible. In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega), MOHM and MHZ are also permissible), K (kilo), M (milli), U (micro) and N (nano). It the unit is missing, the basic unit is used.

Example:
`SENSe:FREQuency:STOP 1.5GHz = SENSe:FREQuency:STOP 1.5E9`

Special numerical

The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as valuesspecial numerical values.

In the case of a query, the numerical value is provided.

Example: Setting command: `SENSe:FREQuency:STOP MAXimum`
Query: `SENSe:FREQuency:STOP?` Response: `3.5E9`

MIN/MAX — MINimum and MAXimum denote the minimum and maximum value.

DEF — DEFault denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the *RST command

UP/DOWN — UP, DOWN increases or reduces the numerical value by one step. The step width can be specified via an allocated step command (see annex C, List of Commands) for each parameter which can be set via UP, DOWN.

INF/NINF — INFinity, Negative INFinity (NINF) Negative INFinity (NINF) represent the numerical values -9.9E37 or 9.9E37, respectively. INF and NINF are only sent as device reponses.

NAN — Not A Number (NAN) represents the value 9.91E37. NAN is only sent as device response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Boolean Parameters

Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. 0 or 1 is provided in a query.

Example: Setting command: `DISPlay:WINDow:STATe ON`
Query: `DISPlay:WINDow:STATe?` Response: `1`

Text

Text parameters observe the syntactic rules for key words, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example: Setting command: `INPut:COUPling GROund`
Query: `INPut:COUPling?` Response `GRO`

Strings

Strings must always be entered in quotation marks (' or ").

Example: `SYSTem:LANGuage "SCPI"` or
`SYSTem:LANGuage 'SCPI'`

Block data

Block data are a transmission format which is suitable for the transmission of large amounts of data. A command using a block data parameter has the following structure:

Example: `HEADer:HEADer #45168xxxxxxxx`

ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all End or other control signs are ignored until all bytes are transmitted..

Overview of Syntax Elements

The following survey offers an overview of the syntax elements.

:	The colon separates the key words of a command. In a command line the colon after the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterix marks a common command.
"	Quotation marks introduce a string and terminate it.
#	The double dagger (#) introduces block data
	A "white space (ASCII-Code 0 to 9, 11 to 32 decimal, e.g.blank) separates header and parameter.

Instrument Model and Command Processing

The instrument model shown in Fig. 5-2 has been made viewed from the standpoint of the servicing of IEC-bus commands. The individual components work independently of each other and simultaneously. They communicate by means of so-called "messages".

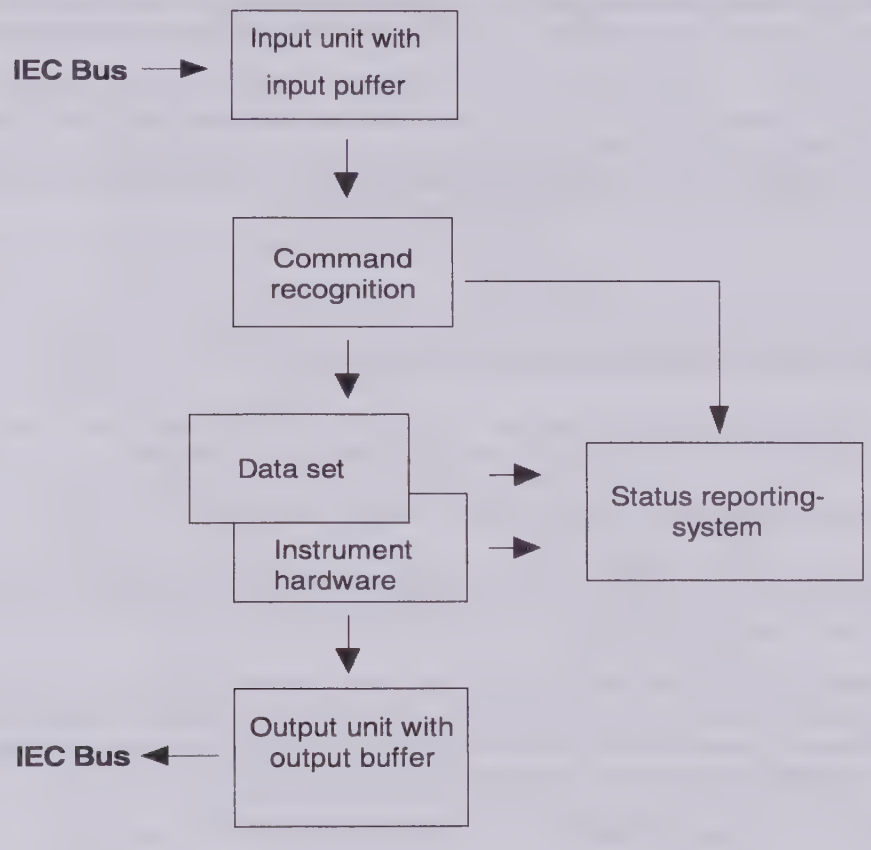

Fig. 5-2 Instrument model in the case of remote control by means of the IEC bus

Input Unit

The input unit receives commands character by character from the IEC bus and collects them in the input buffer. The input unit sends a message to the command recognition as soon as the input buffer is full or as soon as it receives a delimiter, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.
If the input buffer is full, the IEC-bus traffic is stopped and the data received up to then are processed. Subsequently the IEC-bus traffic is continued. If, however, the buffer is not yet full when receiving the delimiter, the input unit can already receive the next command during command recognition and execution. The receipt of a DCL clears the input buffer and immediately initiates a message to the command recognition.

Command Recognition

The command recognition analyses the data received from the input unit. It proceeds in the order in which it receives the data. Only a DCL is serviced with priority, a GET (Group Execute Trigger), e.g., is only executed after the commands received before as well. Each recognized command is immediately transferred to the instrument data base but without being executed there at once.
Syntactical errors in the command are recognized in the command recognition and supplied to the status reporting system. The rest of a command line after a syntax error is analysed further if possible and serviced.
If the command recognition recognizes a delimiter (<PROGRAM MESSAGE SEPARATOR> or <PROGRAM MESSAGE TERMINATOR>) or a DCL, it requests the instrument data base to set the commands in the instrument hardware as well now. Subsequently it is immediately prepared to process commands again. This means for the command servicing that further commands can already be serviced while the hardware is still being set ("overlapping execution").

Instrument Data Base and Instrument Hardware

Here the expression "instrument hardware" denotes the part of the instrument fulfilling the actual instrument function - signal generation, measurement etc. The controller is not included.

The instrument data base is a detailed reproduction of the instrument hardware in the software.

IEC-bus setting commands lead to an alteration in the data set. The data base management enters the new values (e.g. frequency) into the data base, however, only passes them on to the hardware when requested by the command recognition.

The data are only checked for their compatibility among each other and with the instrument hardware immediately before they are transmitted to the instrument hardware. If the detection is made that an execution is not possible, an "execution error" is signalled to the status reporting system. The alteration of the data base are cancelled, the instrument hardware is not reset.

IEC-bus queries induce the data base management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit on request. The exact structure and function are described in Section 3.8

Output Unit

The output unit collects the information requested by the controller, which it receives from the data base management. It processes it according to the SCPI rules and makes it available in the output buffer.
If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data base management, the output unit sends error message "Query UNTERMINATED" to the status reporting system. No data are sent on the IEC bus, the controller waits until it has reached its time limit. This behaviour is specified by SCPI.

Command Sequence and Command Synchronization

What has been said above makes clear that all commands can potentially be carried out overlapping.

In order to prevent an overlapping execution of commands, one of commands *OPC, *OPC? or *WAI must be used. All three commands cause a certain action only to be carried out after the hardware has been set and has settled. By a suitable programming, the controller can be forced to wait for the respective action to occur (cf. Table 5-1).

Table 5-1 Synchronisation using *OPC, *OPC? and *WAI

Command	Action after the hardware has settled	Programming the controller
*OPC	Setting the opteration-complete bit in the ESR	- Setting bit 0 in the ESE - Setting bit 5 in the SRE - Waiting for service request (SRQ)
*OPC?	Writing a "1" into the output buffer	Addressing the instrument as a talker
*WAI	Continuing the IEC-bus handshake	Sending the next command

An example as to command synchronization can be found in Chapter "Program Examples".

Status Reporting System

The status reporting system (cf. Fig. 5-4) stores all information on the present operating state of the instrument, e.g. that the instrument presently carries out a calibration and on errors which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via IEC bus.

The information is of a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated mask register standard event status enable (ESE) and registers STATus:OPERation and STATus:QUEStionable which are defined by SCPI and contain detailed information on the instrument.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills the same function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in Fig. 5-4.

Structure of an SCPI Status Register

Each SCPI register consists of 5 parts which each have a width of 16 bits and have different functions (cf. Fig. 5-3). The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. For example, bit 3 of the STATus:OPERation register is assigned to the hardware status "wait for trigger" in all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integer.

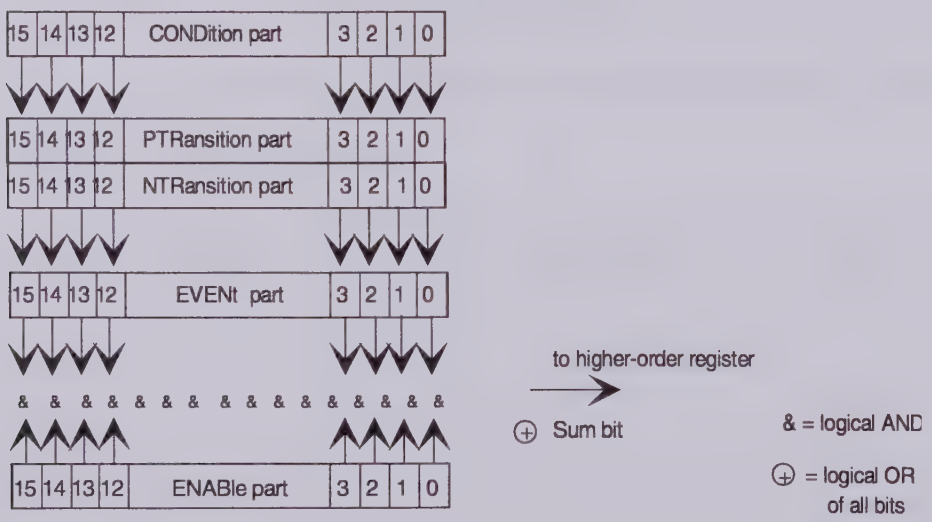
15 14 13 12 CONDition part 3 2 1 0
15 14 13 12 PTRansition part 3 2 1 0
15 14 13 12 NTRansition part 3 2 1 0
15 14 13 12 EVENt part 3 2 1 0
& & & & & & & & & & & & & & &
15 14 13 12 ENABle part 3 2 1 0
to higher-order register
⊕ Sum bit
& = logical AND
⊕ = logical OR of all bits

Fig. 5-3 The status-register model

CONDition part

The CONDition part is directly written into by the hardware or the sum bit of the next lower register. Its contents reflects the current instrument status. This register part can only be read, but not written into or cleared. Its contents is not affected by reading.

PTRansition part

The Positive-TRansition part acts as an edge detector. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1.
PTR bit =1: the EVENt bit is set.
PTR bit =0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

NTRansition part

The Negative-TRansition part also acts as an edge detector. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
NTR-Bit = 1: the EVENt bit is set.
NTR-Bit = 0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

With these two edge register parts the user can define which state transition of the condition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.

EVENt part

The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the edge filters. It is permanently updated by the instrument. This part can only be read by the user. During reading, its contents is set to zero. In linguistic usage this part is often equated with the entire register.

ENABle part

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (cf. below). Each bit of the EVENt part is ANDed with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+').
ENABle-Bit = 0: the associated EVENt bit does not contribute to the sum bit
ENABle-Bit = 1: if the associated EVENT bit is "1", the sum bit is set to "1" as well.
This part can be written into and read by the user at will. Its contents is not affected by reading.

Sum bit

As indicated above, the sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.
The instrument automatically generates the sum bit for each register. Thus an event, e.g. a PLL that has not locked, can lead to a service request throughout all levels of the hierarchy.

Note: *The service request enable register SRE defined in IEEE 488.2 can be taken as ENABle part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be taken as the ENABle part of the ESR.*

Overview of the Status Registers

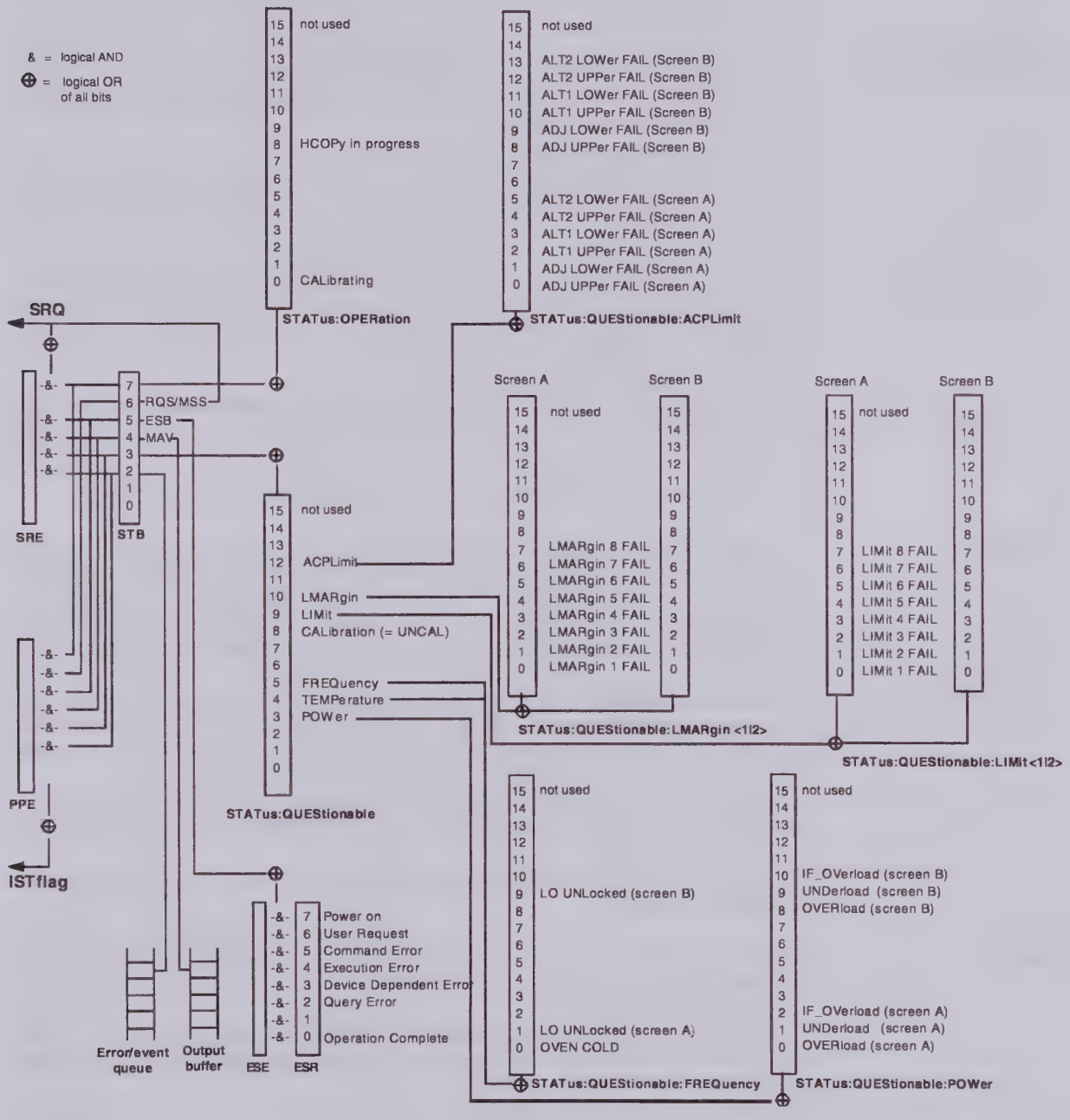

Fig. 5-4 Overview of the status registers

Description of the Status Registers

Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. It can thus be compared with the CONDition part of an SCPI register and assumes the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.
The STATUS BYTE is read out using the command "*STB?" or a serial poll.

The STB implies the SRE. It corresponds to the ENABle part of the SCPI registers as to its function. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) is generated on the IEC bus, which triggers an interrupt in the controller if this is appropriately configured and can be further processed there.
The SRE can be set using command "*SRE" and read using "*SRE?".

Table 5-2 Meaning of the bits in the status byte

Bit No.	Meaning
2	**Error Queue not empty** The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a Service Request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with IEC-bus control.
3	**QUEStionable status sum bit** The bit is set if an EVENt bit is set in the QUEStionable: status register and the associated ENABle bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by polling the QUEStionable status register.
4	**MAV bit** (message available) The bit is set if a message is available in the output buffer which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller (cf. annex D, program examples).
5	**ESB bit** Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit implies an error or an event which can be specified in greater detail by polling the event status register.
6	**MSS bit** (master status summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this registers is set together with its mask bit in the service request enable register SRE.
7	**OPERation status register sum bit** The bit is set if an EVENt bit is set in the OPERation-Status register and the associated ENABle bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be determined by polling the OPERation-status register.

IST Flag and Parallel Poll Enable Register (PPE)

By analogy with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (cf. Section 3.8.4.3) or using command "*IST?".

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, with bit 6 being used as well in contrast to the SRE. The Ist flag results from the ORing of all results. The PPE can be set using commands "*PRE" and read using command "*PRE?".

Event-Status Register (ESR) and Event-Status-Enable Register (ESE)

The ESR is already defined in IEEE 488.2. It can be compared with the EVENt part of an SCPI register. The event status register can be read out using command "*ESR?".
The ESE is the associated ENABle part. It can be set using command "*ESE" and read using command "*ESE?".

Table 5-3 Meaning of the bits in the event status register

Bit No.	Meaning
0	**Operation Complete** This bit is set on receipt of the command *OPC exactly when all previous commands have been executed.
1	This bit is not used
2	**Query Error** This bit is set if either the controller wants to read data from the instrument without having send a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
4	**Execution Error** This bit is set if a received command is syntactically correct, however, cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
5	**Command Error** This bit is set if a command which is undefined or syntactically incorrect is received. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue (cf. Section "Error Messages").
6	**User Request** This bit is set on pressing the *LOCAL* key.
7	**Power On** (supply voltage on) This bit is set on switching on the instrument.

STATus:OPERation Register

In the CONDition part, this register contains information on which actions the instrument is being executing or, in the EVENt part, information on which actions the instrument has executed since the last reading. It can be read using commands `"STATus:OPERation:CONDition?"` or `"STATus :OPERation[:EVENt]?"`.

Table 5-4 Meaning of the bits in the STATus.OPERation register

Bit No.	Meaning
0	**CALibrating** This bit is set as long as the instrument is performing a calibration.
1 to 7	These bits are not used
8	**HardCOPy in progress** This bit is set while the instrument is printing a hardcopy.
9 to 14	These bits are not used
15	This bit is always 0

STATus:QUEStionable Register

This register comprises information about indefinite states which may occur if the unit is operated without meeting the specifications. It can be queried by commands `STATus:QUEStionable:CONDition?` and `STATus:QUEStionable[:EVENt]?`.

Table 5-5 Meaning of bits in STATus:QUEStionable register

Bit No.	Meaning
0 to 2	These bits are not used
3	**POWer** This bit is set if a questionable power occurs (cf. also section "STATus:QUEStionable:POWer Register")
4	**TEMPerature** This bit is set if a questionable temperature occurs.
5	**FREQuency** The bit is set if a frequency is questionable (cf. section "STATus:QUEStionable:FREQuency Register")
6 to 7	These bits are not used
8	**CALibration** The bit is set if a measurement is performed uncalibrated (≙ label "UNCAL")
9	**LIMit** (device-specific) This bit is set if a limit value is violated (see also section STATus:QUEStionable:LIMit Register)
10	**LMARgin** (device-specific) This bit is set if a margin is violated (see also section STATus:QUEStionable:LMARgin Register)
11	Device specific- not used
12	**ACPLimit** (device-specific) This bit is set if a limit for the adjacent channel power measurement is violated (see also section "STATus:QUEStionable:ACPLimit Register")
13 to 14	These bits are not used
15	This bit is always 0.

STATus QUEStionable:ACPLimit Register

This register comprises information about the observance of limits during adjacent power measurements. It can be queried with commands 'STATus:QUEStionable:ACPLimit :CONDition?' and 'STATus:QUEStionable:ACPLimit[:EVENt]?'

Table 5-6 Meaning of bits in STATus:QUEStionable:ACPLimit register

Bit No.	Meaning
0	**ADJ UPPer FAIL(Screen A)** This bit is set if in screen A. the limit is exceeded in the upper adjacent channel
1	**ADJ LOWer FAIL (Screen A)** This bit is set if in screen A the limit is exceeded in the lower adjacent channel.
2	**ALT1 UPPer FAIL (Screen A)** This bit is set if in screen A the limit is exceeded in the upper 1st alternate channel.
3	**ALT1 LOWer FAIL (Screen A)** This bit is set if in screen A the limit is exceeded in the lower 1st alternate channel.
4	**ALT2 UPPer FAIL (Screen A)** This bit is set if in screen A the limit is exceeded in the upper 2nd alternate channel.
5	**ALT2 LOWer FAIL (Screen A)** This bit is set if in screen A the limit is exceeded in the lower 2nd alternate channel.
6 to 7	not used
8	**ADJ UPPer FAIL (Screen B)** This bit is set if in screen B the limit is exceeded in the upper adjacent channel.
9	**ADJ LOWer FAIL (Screen B)** This bit is set if in screen B the limit is exceeded in the lower adjacent channel.
10	**ALT1 UPPer FAIL (Screen B)** This bit is set if in screen B the limit is exceeded in the upper 1st alternate channel.
11	**ALT1 LOWer FAIL (Screen B)** This bit is set if in screen B the limit is exceeded in the lower 1st alternate channel.
12	**ALT2 UPPer FAIL (Screen B)** This bit is set if in screen B the limit is exceeded in the upper 2nd alternate channel.
13	**ALT2 LOWer FAIL (Screen B)** This bit is set if in screen B the limit is exceeded in the lower 2nd alternate channel.
14	not used
15	This bit is always set to 0.

STATus QUEStionable:FREQuency Register

This register comprises information aboutthe reference and local oscillator.
It can be queried with commands `STATus:QUEStionable:FREQuency:CONDition?` and "`STATus:QUEStionable:FREQuency[:EVENt]?`.

Table 5-7 Meaning of bits in STATus:QUEStionable:FREQuency register

Bit No.	Meaning
0	**OVEN COLD** This bit is set if the reference oscillator has not yet attained its operating temperature. 'OCXO' will then be displayed.
1	**LO UNLocked** (Screen A) This bit is set if the local oscillator no longer locks. 'LOUNL will then be displayed.
2 to 8	not used
9	**LO UNLocked** (Screen B) This bit is set if the local oscillator no longer locks.' LOUNL' will then be displayed.
10 to 14	not used
15	This bit is always 0.

STATus QUEStionable:LIMit<1|2> Register

This register comprises information about the observance of limit lines in the corresponding measurement window (LIMit 1 corresponds to Screen A, LIMit 2 to Screen B). It can be queried with commands `STATus:QUEStionable:LIMit<1|2>:CONDition?` and `STATus:QUEStionable:LIMit<1|2>[:EVENt]?`.

Table 5-8 Meaning of bits in STATus:QUEStionable:LIMit<1|2> register

Bit No.	Meaning
0	**LIMit 1 FAIL** This bit is set if limit line 1 is violated.
1	**LIMit 2 FAIL** This bit is set if limit line 2 is violated.
2	**LIMit 3 FAIL** This bit is set if limit line 3 is violated.
3	**LIMit 4 FAIL** This bit is set if limit line 4 is violated.
4	**LIMit 5 FAIL** This bit is set if limit line 5 is violated.
5	**LIMit 6 FAIL** This bit is set if limit line 6 is violated.
6	**LIMit 7 FAIL** This bit is set if limit line 7 is violated.
7	**LIMit 8 FAIL** This bit is set if limit line 8 is violated.
8 to 14	not used
15	This bit is always 0.

STATus QUEStionable:LMARgin<1|2> Register

This register comprises information about the observance of limit margins in the corresponding measurement window (LMARgin1 corresponds to Screen A, LMARgin2 corresponds to Screen B). It can be queried with commands `STATus:QUEStionable:LMARgin<1|2>:CONDition?` and `"STATus :QUEStionable:LMARgin<1|2>[:EVENt]?.`

Table 5-9 Meaning of bits in STATus:QUEStionable:LMARgin<1|2> register

Bit No.	Meaning
0	**LMARgin 1 FAIL** This bit is set if limit margin 1 is violated.
1	**LMARgin 2 FAIL** This bit is set if limit margin 2 is violated.
2	**LMARgin 3 FAIL** This bit is set if limit margin 3 is violated.
3	**LMARgin 4 FAIL** This bit is set if limit margin 4 is violated.
4	**LMARgin 5 FAIL** This bit is set if limit margin 5 is violated.
5	**LMARgin 6 FAIL** This bit is set if limit margin 1 is violated.
6	**LMARgin 7 FAIL** This bit is set if limit margin 7 is violated.
7	**LMARgin 8 FAIL** This bit is set if limit margin 8 is violated.
8 to 14	not used
15	This bit is always 0.

STATus QUEStionable:POWer Register

This register comprises all information about possible overloads of the unit.
It can be queried with commands `STATus:QUEStionable:POWer:CONDition?` and `"STATus :QUEStionable:POWer[:EVENt]?`.

Table 5-10 Meaning of bits in STATus:QUEStionable:POWer register

Bit No.	Meaning
0	**OVERload** (Screen A) This bit is set if the RF input is overloaded. 'OVLD' will then be displayed.
1	**UNDerload** (Screen A) This bit is set if, during measurements in vector analyzer mode without capture buffer used, the lower level limit in the IF path is violated.
2	**IF_OVerload** (Screen A) This bit is set if the IF path is overloaded. 'IFOVL' will then be displayed.
3 to 7	not used
8	**OVERload** (Screen B) This bit is set if the RF input is overloaded. 'OVLD' will then be displayed.
9	**UNDerload** (Screen B) This bit is set if, during measurements without capture buffer used, the lower level limit in the IF path is violated.
10	**IF_OVerload** (Screen B) This bit is set if the IF path is overloaded. 'IFOVL' will then be displayed.
11 to 14	not used
15	This bit is always 0.

Application of the Status Reporting Systems

In order to be able to effectively use the status reporting system, the information contained there must be transmitted to the controller and further processed there. There are several methods which are represented in the following. Detailed program examples are to be found in annex D, Program Examples.

Service Request, Making Use of the Hierarchy Structure

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react with corresponding actions. As evident from Fig. 5-4, an SRQ is always initiated if one or several of bits 2, 3, 4, 5 or 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of a further register, the error queue or the output buffer. The corresponding setting of the ENABle parts of the status registers can achieve that arbitrary bits in an arbitrary status register initiate an SRQ. In order to make use of the possibilities of the service request, all bits should be set to "1" in enable registers SRE and ESE.

Examples (cf. Fig. 5-4 and annex D, Program Examples, as well):

Use of command "*OPC" to generate an SRQ at the end of a sweep.

- `CALL IBWRT(analyzer%, "*ESE 1")` Set bit 0 in the ESE (Operation Complete)
- `CALL IBWRT(analyzer%, "*SRE 32")` Set bit 5 in the SRE (ESB)?

  After its settings have been completed, the instrument generates an SRQ.

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request. A detailed example for a service request routine is to be found in annex D, Program Examples.

Serial Poll

In a serial poll, just as with command "*STB", the status byte of an instrument is queried. However, the query is realized via interface messages and is thus clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works with instruments which do not adhere to SCPI or IEEE 488.2.

The VISUAL BASIC command for executing a serial poll is "IBRSP()". Serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the IEC bus.

Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 bit of information each on the data lines, i.e., to set the data line allocated to each instrument to logically "0" or "1". By analogy to the SRE register which determines under which conditions an SRQ is generated, there is a parallel poll enable register (PPE) which is ANDed with the STB bit by bit as well considering bit 6. The results are ORed, the result is then sent (possibly inverted) as a response in the parallel poll of the controller. The result can also be queried without parallel poll by means of command "*IST".

The instrument first has to be set for the parallel poll using quick-BASIC command "IBPPC()". This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using "IBRPP()".

The parallel-poll method is mainly used in order to quickly find out after an SRQ which instrument has sent the service request if there are many instruments connected to the IEC bus. To this effect, SRE and PPE must be set to the same value. A detailed example as to the parallel poll is to be found in annex D, Program Examples.

Query by Means of Commands

Each part of every status register can be read by means of queries. The individual commands are indicated in the detailed description of the registers in Section 3.8.3. What is returned is always a number which represents the bit pattern of the register queried. Evaluating this number is effected by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

Error-Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain-text error messages which can be looked at in the ERROR menu via manual control or queried via the IEC bus using command "SYSTem:ERRor?". Each call of "SYSTem:ERRor?" provides an entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

Resetting Values of the Status Reporting System

Table 5-11 comprises the different commands and events causing the status reporting system to be reset. None of the commands, except for *RST and SYSTem:PRESet influences the functional instrument settings. In particular, DCL does not change the instrument settings.

Table 5-11 Resettting instrument functions

Event / Effect	Switching on supply voltage: Power-On-Status-Clear 0	Switching on supply voltage: Power-On-Status-Clear 1	DCL,SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
Clear STB,ESR	—	yes	—	—	—	yes
Clear SRE,ESE	—	yes	—	—	—	—
Clear PPE	—	yes	—	—	—	—
Clear EVENTt parts of the registers	—	yes	—	—	—	yes
Clear Enable parts of all OPERation and QUEStionable registers, Fill Enable parts of all other registers with "1".	—	yes	—	—	yes	—
Fill PTRansition parts with "1" , Clear NTRansition parts	—	yes	—	—	yes	—
Clear error queue	yes	yes	—	—	—	yes
Clear output buffer	yes	yes	yes	1)	1)	1)
Clear command processing and input buffer	yes	yes	yes	—	—	—

1) Every command being the first in a command line, i.e., immediately following a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.

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6 Remote Control - Description of Commands

Notation

In the following sections, all s implemented in the instrument are first listed in tables and then described in detail, separated according to the command system. The notation largely corresponds to the SCPI standard. The SCPI conformity information can be taken from the individual description of the commands.

Table of Commands

Command: In the command column, the table provides an overview of the commands and their hierarchical arrangement (see indentations).

Parameter: The parameter column indicates the requested parameters together with their specified range.

Unit: The unit column indicates the basic unit of the physical parameters.

Remark: In the remark column an indication is made on:
- whether the command does not have a query form,
- whether the command has only one query form
- whether the command is implemented only with a certain option of the instrument

Indentations

The different levels of the SCPI command hierarchy are represented in the table by means of indentations to the right. The lower the level, the farther the indentation to the right. Please observe that the complete notation of the command always includes the higher levels as well.

Example: `SENSe:FREQuency:CENTer` is represented in the table as follows:

`SENSe`	first level
`:FREQuency`	second level
`:CENTer`	third level

Individual description

In the individual description, the complete notation of the command is given. An example for each command, the *RST value and the SCPI information is written out at the end of the individual description.
The modes for which a command can be used are indicated by the following abbreviations:

A	Spectrum analysis
A-F	Spectrum analysis - frequency domain only
A-Z	Spectrum analysis - time domain only (zero span)

Upper/lower case notation Upper/lower case letters serve to mark the long or short form of the key words of a command in the description (see Section 3.5.2). The instrument itself does not distinguish between upper and lower case letters.

Special characters |

A selection of key words with an identical effect exists for several commands. These keywords are indicated in the same line, they are separated by a vertical stroke. Only one of these keywords has to be indicated in the header of the command. The effect of the command is independent of which of the keywords is indicated.

Example: `SENSe:FREQuency:CW|:FIXed`

The two following commands of identical meaning can be formed. They set the frequency of the constantly frequent signal to 1 kHz:

`SENSe:FREQuency:CW 1E3 = SENSe:FREQuency:FIXed 1E3`

A vertical stroke in parameter indications marks alternative possibilities in the sense of "or". The effect of the command is different, depending on which parameter is entered.

Example: Selection of the parameters for the command

`DISPlay:FORMat FULL | SPLit`

If parameter FULL is selected, full screen is displayed, in the case of SPLit, split screen is displayed.

[ ] Key words in square brackets can be omitted when composing the header (cf. Section 3.5.2, Optional Keywords). The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards.
Parameters in square brackets can optionally be incorporated in the command or omitted as well.

{ } Parameters in braces can optionally be incorporated in the command either not at all, once or several times.

Description of parameters Due to the standardization, the parameter section of SCPI commands consists always of the same syntactical elements. SCPI has therefore specified a series of definitions, which are used in the tables of commands. In the tables, these established definitions are indicated in angled brackets (<...>) and will be briefly explained in the following (see also Section 3.5.5, "Parameters").

<Boolean> This indication refers to parameters which can adopt two states, "on" and "off". The "off" state may either be indicated by the keyword **OFF** or by the numeric value 0, the "on" state is indicated by **ON** or any numeric value other than zero. Parameter queries are always returned the numeric value 0 or 1.

<numeric_value>

<num> These indications mark parameters which may be entered as numeric values or be set using specific keywords (character data).

The following keywords given below are permitted:

MINimum	This keyword sets the parameter to the smallest possible value.
MAXimum	This keyword sets the parameter to the largest possible value.
DEFault	This keyword is used to reset the parameter to its default value.
UP	This keyword increments the parameter value.
DOWN	This keyword decrements the parameter value.

The numeric values associated to MAXimum/MINimum/DEFault can be queried by adding the corresponding keywords to the command. They must be entered following the quotation mark.

Example: `SENSe:FREQuency:CENTer? MAXimum`

returns the maximum possible numeric value of the center frequency as result.

<arbitrary block program data>

This keyword is provided for commands the parameters of which consist of a binary data block.

Common Commands

The common commands are taken from the IEEE 488.2 (IEC 625-2) standard. A particular command has the same effect on different devices. The headers of these commands consist of an asterisk "*" followed by three letters. Many common commands refer to the status reporting system which is described in detail in Section 3.8.

Command	Parameter	Designation	Remark
CAL?		Calibration Query	query only
CLS		Clear Status	no query
ESE	0 to 255	Event Status Enable	
ESR?		Standard Event Status Query	query only
IDN?		Identification Query	query only
IST?		Individual Status Query	query only
OPC		Operation Complete	
OPT?		Option Identification Query	query only
PCB	0 to 30	Pass Control Back	no query
PRE	0 to 255	Parallel Poll Register Enable	
PSC	0 | 1	Power On Status Clear	
RST		Reset	no query
SRE	0 to 255	Service Request Enable	
STB?		Status Byte Query	query only
TRG		Trigger	no query
TST?		Self Test Query	query only
WAI		Wait to continue	no query

***CAL?**

CALIBRATION QUERY initiates a calibration of the instrument and subsequently query the calibration status. Any responses > 0 indicate errors.

***CLS**

CLEAR STATUS sets the status byte (STB), the standard event register (ESR) and the EVENt-part of the QUEStionable and the OPERation register to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

***ESE 0 to 255**

EVENT STATUS ENABLE sets the event status enable register to the value indicated. Query *ESE? returns the contents of the event status enable register in decimal form.

***ESR?**

STANDARD EVENT STATUS QUERY returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.

***IDN?**

IDENTIFICATION QUERY queries the instrument identification.
The instrument identification consists of the following elements which are separated by commas:
Manufacturer
Device
Serial number of the instrument
Firmware version number
Example: " Rohde&Schwarz, FSP7, 123456/789, 1.03"

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 I 1). The IST flag is the status bit which is sent during a parallel poll (cf. Section 3.8.3.2).

***OPC**

OPERATION COMPLETE sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request (cf. Section 3.7).

***OPC?**

OPERATION COMPLETE QUERY writes message "1" into the output buffer as soon as all preceding commands have been executed (cf. Section 3.7).

***OPT?**

OPTION IDENTIFICATION QUERY queries the options included in the instrument and returns a list of the options installed. The options are separated from each other by means of commas.

Position	Option	
1	FSP-B3	Audio Demodulator
2	FSP-B4	OCXO
3 and higher		reserved

Example: B3, B4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

***PCB 0 to 30**

PASS CONTROL BACK indicates the controller address which the IEC-bus control is to be returned to after termination of the triggered action.

***PRE 0 to 255**

PARALLEL POLL REGISTER ENABLE sets parallel poll enable register to the value indicated. Query *PRE? returns the contents of the parallel poll enable register in decimal form.

***PSC 0 | 1**

POWER ON STATUS CLEAR determines whether the contents of the ENABle registers is maintained or reset following power-up.

*PSC = 0 causes the contents of the status registers to be maintained. Thus a service request can be triggered in switching on in the case of a corresponding configuration of status registers ESE and SRE.

*PSC ≠ 0 resets the registers.

Query *PSC? reads out the contents of the power-on-status-clear flag. The response can be 0 or 1.

***RST**

RESET sets the instrument to a defined default status. The command essentially corresponds to pressing the *PRESET* key. The default setting is indicated in the description of the commands.

***SRE 0 to 255**

SERVICE REQUEST ENABLE sets the service request enable register to the value indicated. Bit 6 (MSS mask bit) remains 0. This command determines under which conditions a service request is triggered. Query *SRE? reads the contents of the service request enable register in decimal form. Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY reads out the contents of the status byte in decimal form.

***TRG**

TRIGGER initiates a measurement. This command corresponds to `INITiate:IMMediate` (cf. Section "TRIGger subsystem", as well).

***TST?**

SELF TEST QUERY initiates all selftests of the instrument and outputs an error code in decimal form.

***WAI**

WAIT-to-CONTINUE permits the servicing of subsequent commands only after all preceding commands have been executed and all signals have settled (cf. Section 3.7 and "*OPC" as well).

ABORt Subsystem

The ABORt subsystem contains the commands for aborting triggered actions. An action can be triggered again immediately after being aborted. All commands trigger events and so they are not assigned any *RST value.

COMMAND	PARAMETERS	UNIT	COMMENT
ABORt		--	no query

ABORt

This command aborts a current measurement and resets the trigger system.

Example: `"ABOR;INIT:IMM"`

Features: *RST value: 0
SCPI: conforming

Mode: A

CALCulate Subsystem

The CALCulate subsystem contains commands for converting instrument data, transforming and carrying out corrections. These functions are carried out subsequent to data acquistion, ie following the SENSe subsystem.

The numeric suffix is used in CALCulate to make the distinction between the two measurement windows SCREEN A and SCREEN B:

CALCulate1 = Screen A
CALCulate2 = Screen B.

For commands without suffix, screen A is selected automatically.

Full Screen — The settings are valid for the measurement window selected with the numeric suffix. They become effective as soon as the corresponding measurement window has been selected as active measurement window using the command `DISPLay[:WINDow<1|2>]:SELect`. Triggering measurements and querying measured values is possible only in the active measurement window.

Split Screen — The settings are valid for the measurement window selected by means of the numeric suffix and become immediately effective.

CALCulate:DELTamarker Subsystem

The CALCulate:DELTamarker subsystem checks the delta-marker functions in the instrument. The measurement measurement windows are assigned to CALCulate 1 (screen A) or 2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:DELTamarker<1 to 4>			
[:STATe]	<Boolean>	--	
:MODE	ABSolute|RELative		
:AOFF			no query
:TRACe	<numeric_value>	--	
:X	<numeric_value>	HZ | S | DBM | DB	
:RELative?	--		query only
:Y?	--	--	query only
:MAXimum		--	
[:PEAK]	--		no query
:NEXT	--	--	no query
:RIGHt	--	--	no query
:LEFT	--	--	no query
:MINimum		--	
[:PEAK]	--		no query
:NEXT	--	--	no query
:RIGHt	--	--	no query
:LEFT	--	--	no query
		--	
:FUNCtion			
:FIXed			
[:STATe]	<Boolean>		
:RPOint			
:Y	<numeric_value>	DBM	
:OFFSet	<numeric_value>	DB	
:X	<numeric_value>	HZ | S	
:PNOise			
[:STATe]	<Boolean>		
:RESult?	--	--	query only

CALCulate<1|2>:DELTamarker<1 to 4>[:STATe] ON | OFF

This command switches on and off the delta marker when delta marker 1 is selected. The corresponding marker becomes the delta marker when delta marker 2 to 4 is selected. If the corresponding marker is de-activated, it is activated and positioned to the maximum of the measurement curve.
If no indication is made, delta marker 1 is selected automatically.

Example: `"CALC:DELT3 ON"` Switches marker 3 in screen A to delta marker mode.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:MODE ABSolute | RELative

This command switches between relative and absolute input of frequency of the delta marker (or time with span = 0). It acts on all delta markers independently of the measurement window.

Example: `"CALC:DELT:MODE ABS"` Switches the frequency/time indication for all delta markers to absolute values.

`"CALC:DELT:MODE REL"` Switches the frequency/time indication for all delta markers to relative to marker 1.

Features: *RST value: REL
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:AOFF

This command switches off all active delta markers in the selected measurement window (screen A or screen B).

Example: `"CALC2:DELT:AOFF"` Switches off all delta markers in screen B.

Features: *RST value: -
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:TRACe 1 to 3

This command assigns the selected delta marker to the indicated measurement curve.

Example: `"CALC:DELT3:TRAC 2"` Assigns deltamarker 3 to trace 2 in screen A.
`"CALC:DELT:TRAC 3"` Assigns deltamarker 1 to trace 3 in screen B.

Features: *RST value: -
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:X 0 to MAX (frequency | sweep time)

This command positions the selected delta marker to the indicated frequency (span > 0), time (span = 0) or level (APD measurement = ON or CCDFmeasurement = ON). The entry is in absolute values or relative to marker 1 depending on the command `CALCulate:DELTamarker:MODE`. If Reference Fixed (`CALCulate:DELTamarker:FUNCtion:FIXed:STATe ON`) is active, relative values referred to the reference position are entered. The query always returns the absolute value.

Example: `"CALC:DELT:MOD REL"` Switches the input for all delta markers to relative to marker 1.

`"CALC:DELT2:X 10.7MHz"` Positions delta marker 2 in screen A 10.7 MHz right to marker 1.

`"CALC2:DELT:X?"` Outputs the absolute frequency/time of delta marker 1 in screen B

`"CALC2:DELT:X:REL?"` Outputs the relative frequency/time/level of delta marker 1 in screen B

Features: *RST value: -
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:X:RELative?

This command queries the frequency (span > 0) or time (span = 0) of the selected delta marker relative to marker 1 or to the reference position (for `CALCulate:DELTamarker:FUNCtion :FIXed:STATe ON`). The command first activates the corresponding delta marker, if necessary.

Example: `"CALC:DELT:X:REL?"` Outputs the frequency of delta marker 3 in screen B relative to marker 1 or relative to the reference position.

Features: *RST value: -
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:Y?

This command queries the measured value of the selected delta marker in the indicated measurement window. The corresponding delta marker is first activated, if necessary. The output is always a relative value referred to marker 1 or to the reference position (reference fixed active).

To obtain a valid query result, a complete sweep with synchronization to the sweep end should have been performed between the activation of the delta marker and the query of the y value. This is only possible in the single-sweep mode.

Depending on the unit defined with `CALCulate:UNIT` or on the activated statistics functions, the query result is output in the units below:

- DBM | DBPW | DBUV | DBMV | DBUA: Output unit DB
- WATT | VOLT | AMPere: Output unit W | V | A
- Statistics function (APD or CCDF) on: Dimensionless output

Example:
`"INIT:CONT OFF"` Switches to single-sweep mode.
`"CALC:DELT2 ON"` Switches on delta marker 2 in screen A.
`"INIT;*WAI"` Starts a sweep and waits for the end.
`"CALC:DELT2:Y?"` Outputs the reading of delta marker 2 in screen A.

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum[:PEAK]

This command positions the delta marker to the current maximum value in the trace memory. If necessary, the corresponding delta marker is first activated.

Example: `"CALC2:DELT3:MAX"` Sets delta marker 3 in screen B to the maximum value of the associated trace.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:NEXT

This command positions the delta marker to the next smaller maximum value in the trace memory. The corresponding delta marker is first activated, if necessary.

Example: `"CALC1:DELT2:MAX:NEXT"` Sets delta marker 2 in screen A to the next smaller maximum value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:RIGHt

This command positions the delta marker to the next smaller maximum value to the right of the current value (ie ascending X values) in the trace memory. The corresponding delta marker is first activated, if necessary.

Example: `"CALC2:DELT:MAX:RIGH"` Sets delta marker 1 in screen B to the next smaller maxikmum value to the right of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:LEFT

This command positions the delta marker to the next smaller maximum value to the left of the current value (ie descending X values) in the trace memory. The corresponding delta marker is first activated, if necessary.

Example: `"CALC:DELT:MAX:LEFT"` Sets delta marker 1 in screen A to the next smaller maximum value to the left of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:MINimum[:PEAK]

This command positions the delta marker to the current minimum value in the trace memory. The corresponding delta marker is first activated, if necessary.

Example: `"CALC2:DELT3:MIN"` Sets delta marker 3 in screen B to the minimum value of the associated trace.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:NEXT

This command positions the delta marker to the next higher minimum value in the trace memory. The corresponding delta marker is first activated, if necessary.

Example: `"CALC1:DELT2:MIN:NEXT"` Sets delta marker 2 in screen A to the next higher minimum value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:RIGHt

This command positions the delta marker to the next higher minimum value to the right of the current value (ie ascending X values). The corresponding delta marker is first activated, if necessary.

Example: `"CALC2:DELT:MIN:RIGH"` Sets delta marker 1 in screen B to the next higher minimum value to the right of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:LEFT

This command positions the delta marker to the next higher minimum value to the left of the current value (ie descending X values). The corresponding delta marker is first activated, if necessary.

Example: `"CALC:DELT:MIN:LEFT"` Sets delta marker 1 in screen A to the next higher minimum to the left of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed[:STATe] ON | OFF

This command switches the relative measurement to a fixed reference value on or off. Marker 1 is first activated and a peak search is performed, if necessary. If marker 1 is activated, its position becomes the reference point for the measurement. The reference point can then be modified with commands `CALCulate:DELTamarker :FUNCtion:FIXed:RPOint:X` and `...:RPOint:Y` independently of the position of marker 1 and of a trace. It is valid for all delta markers in the selected measurement window when the function is active.

Example: `"CALC2:DELT:FUNC:FIX ON"` Switches on the measurement with fixed reference value for all delta markers in screen B.

`"CALC2:DELT:FUNC:FIX:RPO:X 128 MHZ"` Sets the reference frequency in screen B to 128 MHz.

`"CALC2:DELT:FUNC:FIX:RPO:Y 30 DBM"` Sets the reference level in screen B to +30 dBm

Features: *RST value: OFF
SCPI: device-specific.

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y <numeric_value>

This command defines a new reference level for all delta markers in the selected measurement window for a measurement with fixed reference point.
(`CALCulate:DELTamarker:FUNCtion:FIXed:STATe ON`).

For phase-noise measurements (`CALCulate:DELTamarker:FUNCtion:PNOise:STATe ON`), the command defines a new reference level for delta marker 2 in the selected measurement window.

Example: `"CALC:DELT:FUNC:FIX:RPO:Y -10dBm"` Sets the reference level for delta markers in screen A to -10 dBm.

Features: *RST value: - (`FUNCtion:FIXed[:STATe]` is set to OFF)
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y:OFFSet <numeric_value>

This command defines an additional level offset for the measurement with fixed reference value (`CALCulate:DELTamarker:FUNCtion:FIXed:STATe ON`). For this measurement, the offset is included in the display of all delta markers of the selected measurement window.

For phase-noise measurements (`CALCulate:DELTamarker:FUNCtion:PNOise:STATe ON`), the command defines an additional level offset which is included in the display of delta marker 2 in the selected measurement window.

Example: `"CALC:DELT:FUNC:FIX:RPO:Y:OFFS 10dB"`
sets the level offset for the measurement with fixed reference value or the phase-noise measurement in screen A to 10 dB.

Features: *RST value: 0 dB
SCPI: device-specific

Mode: A

The level offset is included in the output of the level value.

CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:X <numeric_value>

This command defines a new reference frequency (span > 0) or time (span = 0) for all delta markers in the selected measurement window for a measurement with a fixed reference value (`CALCulate:DELTamarker:FUNCtion:FIXed:STATe ON`).

For phase-noise measurements (`CALCulate:DELTamarker:FUNCtion:PNOise:STATe ON`), the command defines a new reference frequency or time for delta marker 2 in the selected measurement window.

Example: `"CALC2:DELT:FUNC:FIX:RPO:X 128MHz"` Sets the reference frequency in screen B to 128 MHz.

Features: *RST value: - (`FUNction:FIXed[:STATe]` is set to `OFF`)
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:PNOise[:STATe] ON | OFF

This command switches on or off the phase-noise measurement with all actíve delta markers in the selected measurement window. The correction values for the bandwidth and the log amplifier are taken into account in the measurement..

Marker 1 is first activated, if necessary, and a peak search is performed. If marker 1 is activated, its position becomes the reference point for the measurement.

The reference point can then be modified with commands `CALCulate:DELTamarker :FUNCtion:FIXed:RPOint:X` and `...:RPOint:Y` independently of the position of marker 1 and of a trace (the same commands used for the measurment with fixed reference point).

The numeric suffix <1 to 4> with `DELTamarker` has no significance for this command.

Example: `"CALC:DELT:FUNC:PNO ON"` Switches on the phase-noise measurement with all delta markers in screen A.

`"CALC:DELT:FUNC:FIX:RPO:X 128 MHZ"` Sets the reference frequency to 128 MHz.

`"CALC:DELT:FUNC:FIX:RPO:Y 30 DBM"` Sets the reference level to +30 dBm

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:PNOise:RESult?

This command queries the result of the phase-noise measurement in the selected measurement window.The measurement is first switched on, if necessary.

Example: `"CALC:DELT:FUNC:PNO:RES?"` Outputs the result of phase-noise measurement of the selected delta marker in screen A.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is only a query and is therefore not assigned an *RST value.

CALCulate:LIMit Subsystem

The CALCulate:LIMit subsystem comprises the limit lines and the corresponding limit checks. Limit lines can be defined as upper and lower limit lines. The individual Y values of the limit lines correspond to the values of the X-axis (CONTrol) which have to have the same number.
8 limit lines can be active at the same time (marked by LIMIT1 to LIMIT8) and activated in screen A and/or screen B. The measurement windows are assigned to CALCulate 1 (screen A) or 2 (screen B).

The limit check can be switched on separately for each measurement window and limit line.

Each limit line can be allocated a name (max. 8 letters) under which the line is stored in the instrument. An explanatory comment can also be given for each line (max. 40 characters).

Example:
Definition and use of a new limit line 5 for trace 2 in screen A and trace 1 in screen B with the following features:

- upper limit line
- absolute X-axis in the frequency domain
- 5 ref. values: 126 MHz/-40 dB, 127 MHz/-40 dB, 128 MHz/-20 dB, 129 MHz/-40 dB, 130 MHz/-40 dB
- relative Y-axis with unit dB
- absolute threshold value at -35 dBm
- no safety margin

Definition of the line:

1. Defining the name:	`CALC:LIM5:NAME 'TEST1'`
2. Entering the comment:	`CALC:LIM5:COMM ''Upper limit line"`
3. Associated trace in screen A:	`CALC1:LIM5:TRAC 2`
4. Associated trace in screen B:	`CALC2:LIM5:TRAC 1`
5. Defining the X-axis range:	`CALC:LIM5:CONT:DOM FREQ`
6. Defining the X-axis scaling:	`CALC:LIM5:CONT:MODE ABS`
7. Defining the Y-axis unit:	`CALC:LIM5:UNIT DB`
8. Defining the Y-axis scaling:	`CALC:LIM5:UPP:MODE REL`
9. Defining the X-axis values:	`CALC:LIM5:CONT 126MHZ, 127MHZ, 128MHZ, 129 MHZ, 130MHZ`
10. Defining the y values:	`CALC:LIM5:UPP -40, -40, -30, -40, -40`
11. Defining the y threshold value:	`CALC:LIM5:UPP:THR -35DBM`

The definition of the safety margin and shifting in X- and/or Y-direction can take place as from here (see commands below).

Switching on and evaluating the line in screen A:

1. Switching on the line in screen A:	`CALC1:LIM5:UPP:STAT ON`
2. Switching on the limit check in screen A:	`CALC1:LIM5:STAT ON`
3. Starting a new measurement with synchronization:	`INIT;*WAI`
4. Querying the limit check result:	`CALC1:LIM5:FAIL?`

Switching on and evaluating the line in screen B is performed similarly by means of `CALC2` instead of `CALC1`.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:LIMit<1 to 8>			
:TRACe	<numeric_value>		
:STATe	<Boolean>	--	
:UNIT	DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DB | DBUV_M | DBUA_M | DEG | RAD | S | HZ | PCT | UNITLESS		
:FAIL?		--	query only
:CLEar			
[:IMMediate]	--	--	no query
:COMMent	<string>	--	
:COPY	1 to 8 | < name>	--	
:NAME	<string>		
:DELete	--		

CALCulate<1\|2>:LIMit<1 to 8>:TRACe 1 to 3

This command assigns a trace to a limit line.

Examples: `"CALC:LIM2:TRAC 3"` Assigns limit line 2 to trace 3 in screen A.

`"CALC2:LIM2:TRAC 1"` Assigns limit line 2 to trace 1 in screen B at the same time.

Features: *RST value: 1
SCPI: device-specific

Mode: A

CALCulate<1\|2>:LIMit<1 to 8>:STATe ON | OFF

This command switches on or off the limit check for the selected limit line in the selected measurement window.

The result of the limit check can be queried with `CALCulate:LIMit:FAIL?`.

Example: `"CALC:LIM:STAT ON"` Switches on the limit check for limit line 1 in screen A.

`"CALC2:LIM:STAT OFF"` Switches off the limit check for limit line 1 in screen B.

Features: *RST value: OFF
SCPI: conforming

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:UNIT DBM | DBPW | WATT | DBUV | DBMV | VOLT |DBUA | AMPere | DB | DBUV_M | DBUA_M | DEG | RAD | S | HZ | PCT | UNITLESS

This command defines the unit of the selected limit line.

The definition is valid independently of the measurement window.

Example: "CALC:LIM4:UNIT DBUV" Sets the unit of limit line 4 to dBµV.

Features: *RST value: DBM
SCPI: device-specific

Mode: A

Upon selection of the unit DB the limit line is automatically switched to the relative mode. For units different from DB the limit line is automatically switched to the absolute mode.

The units DEG, RAD, S, HZ, PCT are available in the spectrum analysis mode only.

CALCulate<1|2>:LIMit<1 to 8>:FAIL?

This command queries the result of the limit check of the limit line indicated in the selected measurement window. It should be noted that a complete sweep should be performed for obtaining a valid result. A synchronization with *OPC, *OPC? or *WAI should therefore be provided.

The result of the limit check responds with 0 for PASS, 1 for FAIL, and 2 for MARGIN.

Example: "INIT;*WAI" Starts a new sweep and waits for its end.

"CALC2:LIM3:FAIL?" Queries the result of the check for limit line 3 in screen B.

Features: *RST value: -
SCPI: conforming

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:CLEar[:IMMediate]

This command deletes the result of the current limit check for all limit lines in the selected measurement window.

Example: "CALC:LIM:CLE" Deletes the result of the limit check in screen A

Features: *RST value: -
SCPI: conforming

Mode: A

This command is an event and is therefore not assigned an *RST value.

CALCulate<1|2>:LIMit<1 to 8>:COMMent <string>

This command defines a comment for the limit line selected (max. 40 characters). The comment depends on the measurement window.

Example: "CALC:LIM5:COMM 'Upper limit for spectrum'"
Defines the comment for limit line 5.

Features: *RST value: blank comment
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:COPY 1 to 8 | <name>

This command copies one limit line onto another one. It is independent of the measurement window.

Parameter: 1 to 8 ::= number of the new limit line or:
<name> ::= name of the new limit line given as a string

Example: "CALC:LIM1:COPY 2" Copies limit line 1 to line 2.

"CALC:LIM1:COPY 'GSM2'" Copies limit line 1 to a new line named 'GSM2'.

Features: *RST value: --
SCPI: device-specific

Mode: A

The name of the limit line may contain a maximum of 8 characters. This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:LIMit<1 to 8>:NAME <name of limit line>

This command assigns a name to a limit line numbered 1 to 8. If it does not exist already, a limit line with this name is created. It is independent of the measurement window.

Example: "CALC:LIM1:NAME 'GSM1'" Gives limit line 1 the name 'GSM1'.

Features: *RST value: 'REM1' to 'REM8' for lines 1 to 8
SCPI: device-specific

Mode: A

The name of the limit line may contain a maximum of 8 characters.

CALCulate<1|2>:LIMit<1 to 8>:DELete

This command deletes the limit line selected. The command is independent of the measurement window.

Example: "CALC:LIM1:DEL" Deletes limit line 1.

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate:LIMit:ACPower Subsystem

The CALCulate:LIMit:ACPower subsystem defines the limit check for adjacent channel power measurement.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
LIMit<1 to 8>			
:ACPower			
[:STATe]	<Boolean>		
:ACHannel			
[:RELative]	<numeric_value>, <numeric_value>	DB, DB	
:STATe	<Boolean>		
:ABSolute	<numeric_value>, <numeric_value>	DBM, DBM	
:STATe	<Boolean>		
:RESult?	--		query only
:ALTernate<1|2>			
[:RELative]	<numeric_value>, <numeric_value>	DB, DB	
:STATe	<Boolean>		
:ABSolute	<numeric_value>, <numeric_value>	DBM, DBM	
:STATe	<Boolean>		
:RESult?	--		query only

CALCulate<1\|2>:LIMit<1 to 8>:ACPower[:STATe] ON | OFF

This command switches on and off the limit check for adjacent channel power measurements in the selected measurement window. The commands `CALCulate:LIMit:ACPower:ACHannel:STATe` or `CALCulate:LIMit:ACPower:ALTernate:STATe` must be used in addition to specify whether the limit check is to be performed for the upper/lower adjacent channel or for the alternate adjacent channels.

The numeric suffixes <1 to 8> are irrelevant for this command.

Example: `"CALC:LIM:ACP ON"` Switches on the ACP limit check in screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel[:RELative] 0 to 100 dB, 0 to 100 dB

This command defines the relative limit for the upper/lower adjacent channel for adjacent channel power measurements for the selected measurement window. The reference value for the relative limit value is the measured channel power.

It should be noted that the relative limit value has no effect on the limit check as soon as it is below the absolute limit value defined with `CALCulate:LIMit:ACPower:ACHannel:ABSolute`. This mechanism allows automatic checking of the absolute basic values of adjacent channel power as defined in mobile radio standards.

The numeric suffixes <1 to 8> are irrelevant for this command.

Parameter: The first numeric value is the limit for the upper (lower) adjacent channel. The second limit is ignored but should be indicated for reasons of compatibility with the FSE family.

Example: `"CALC:LIM:ACP:ACH 30DB, 30DB"` Sets the relative limit value in screen A for the power in the lower and upper adjacent channel to 30 dB below the channel power.

Features: *RST value: 0 dB
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel[:RELative]:STATe ON | OFF

This command activates the limit check for the relative limit value of the adjacent channel when adjacent channel power measurement is performed. Before the command, the limit check must be activated using `CALCulate:LIMit:ACPower:STATe ON`.

The result can be queried with `CALCulate:LIMit:ACPower:ACHannel:RESult?`. It should be noted that a complete measurement should be performed between switching on the limit check and the result query, since otherwise no valid results are obtained.

The numeric suffixes <1 to 8> are irrelevant for this command.

Example:

`"CALC:LIM:ACP:ACH 30DB, 30DB"`
Sets the relative limit value in screen A for the power in the lower and upper adjacent channel to 30 dB below the channel power.

`"CALC:LIM:ACP:ACH:ABS -35DBM, -35DBM"`
Sets the absolute limit value in screen A for the power in the lower and upper adjacent channel to -35 dB.

`"CALC:LIM:ACP ON"`
Switches on globally the limit check for the channel/adjacent channel measurement in screen A.

`"CALC:LIM:ACP:ACH:REL:STAT ON"` Switches on the check of the relative limit values for adjacent channels in screen A.

`"CALC:LIM:ACP:ACH:ABS:STAT ON"` Switches on the check of absolute limit values for the adjacent channels in screen A.

`"INIT;*WAI"`
Starts a new measurement and waits for the sweep end.

`"CALC:LIM:ACP:ACH:RES?"`
Queries the limit check result in the adjacent channels in screen A.

Features:

*RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:ABSolute -200DBM to 200DBM, -200 to 200DBM

This command defines the absolute limit value for the lower/upper adjacent channel during adjacent-channel power measurement (Adjacent Channel Power) in the selected measurement window.

It should be noted that the absolute limit value has no effect on the limit check as soon as it is below the relative limit value defined with `CALCulate:LIMit:ACPower:ACHannel:RELative`. This mechanism allows automatic checking of the absolute basic values of adjacent channel power as defined in mobile radio standards.

The numeric suffixes <1 to 8> in LIMIt are irrelevant for this command.

Parameter: The first value is the limit for the lower and the upper adjacent channel. The second limit value is ignored but should be indicated for reasons of compatibiltiy with the FSE family.

Example: `"CALC:LIM:ACP:ACH:ABS -35DBM, -35DBM"`

Sets the absolute limit value in screen A for the power in the lower and upper adjacent channel to -35 dBm.

Features: *RST value: -200DBM
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:ABSolute:STATe ON | OFF

This command activates the limit check for the adjacent channel when adjacent-channel power measurement (Adjacent Channel Power) is performed. Before the command, the limit check for the channel/adjacent-channel measurement should be globally switched on using `CALC:LIM:ACP ON`.

The result can be queried with `CALCulate:LIMit:ACPower:ACHannel:RESult?`. It should be noted that a complete measurement should be performed between switching on the limit check and the result query, since otherwise no valid results are obtained.

The numeric suffixes <1 to 8> in LIMIt are irrelevant for this command.

Example:

`"CALC:LIM:ACP:ACH 30DB, 30DB"`
Sets the relative limit value in screen A for the power in the lower and upper adjacent channel to 30 dB below the channel power.

`"CALC:LIM:ACP:ACH:ABS -35DBM, -35DBM"`
Sets the absolute limit value in screen A for the power in the lower and upper adjacent channel to -35 dB.

`"CALC:LIM:ACP ON"`
Switches on globally the limit check for the channel/adjacent channel measurement in screen A.

`"CALC:LIM:ACP:ACH:REL:STAT ON"`
Switches on the check of the relative limit values for adjacent channels in screen A.

`"CALC:LIM:ACP:ACH:ABS:STAT ON"`
Switches on the check of absolute limit values for the adjacent channels in screen A.

`"INIT;*WAI"`
Starts a new measurement and waits for the sweep end.

`"CALC:LIM:ACP:ACH:RES?"`
Queries the limit check result in the adjacent channels in screen A.

Features:

*RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:RESult?

This command queries the result of the limit check for the upper/lower adjacent channel in the selected measurement window when adjacent channel power measurement is performed.

If the power measurement of the adjacent channel is switched off, the command initiates a query error.
The numeric suffixes <1|2> or <1 to 8> are irrelevant for this command.

Parameter: The result is returned in the form <result>, <result> where <result> = PASSED | FAILED, and where the first returned value denotes the lower, the second denotes the upper adjacent channel.

Example:

`"CALC:LIM:ACP:ACH 30DB, 30DB"`
Sets the relative limit value in screen A for the power in the lower and upper adjacent channel to 30 dB below the channel power.

`"CALC:LIM:ACP:ACH:ABS -35DBM, -35DBM"`
Sets the absolute limit value in screen A for the power in the lower and upper adjacent channel to -35 dB.

`"CALC:LIM:ACP ON"` Switches on globally the limit check for the channel/adjacent channel measurement in screen A.

`"CALC:LIM:ACP:ACH:STAT ON"` Switches on the limit check for the adjacent channels in screen A.

`"INIT;*WAI"` Starts a new measurement and waits for the sweep end.

`"CALC:LIM:ACP:ACH:RES?"` Queries the limit check result in the adjacent channels in screen A.

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is a query and therefore not assigned an *RST value.

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>[:RELative] 0 to 100DB, 0 to 100 dB.

This command defines the limit for the first/second alternate adjacent channel in the selected measurement window for adjacent channel power measurements. The reference value for the relative limit value is the measured channel power.

The numeric suffix after `ALTernate<1|2>` denotes the first or the second alternate channel. The numeric suffixes <1 to 8> are irrelevant for this command.

It should be noted that the relative limit value has no effect on the limit check as soon as it is below th absolute limit defined with `CALCulate:LIMit:ACPower:ALTernate<1|2>:ABSolute`. This mechanism allows automatic checking of the absolute basic values of adjacent channel power as defined in mobile radio standards.

Parameter: The first value is the limit for the lower and the upper alternate adjacent channel. The second limit value is ignored but should be indicated for reasons of compatibility with the FSE family.

Example: `"CALC:LIM:ACP:ALT2 30DB, 30DB"` Sets the relative limit value in screen A for the power in the lower and upper alternate adjacent channel to 30 dB below the channel power.

Features: *RST value: 0DB
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>[:RELative]:STATe ON | OFF

This command activates the limit check for the first/second alternate adjacent channel in the selected measurement window for adjacent channel power measurements. Before the command, the limit check must be activated using `CALCulate:LIMit:ACPower:STATe ON`.

The numeric suffix after `ALTernate<1|2>` denotes the first or the second alternate channel. The numeric suffixes <1 to 8> are irrelevant for this command.

The result can be queried with `CALCulate:LIMit:ACPower:ALTernate<1|2>:RESult?`. It should be noted that a complete measurement should be performed between switching on the limit check and the result query, since otherwise no valid results are obtained.

Example:

`"CALC:LIM:ACP:ALT2 30DB, 30DB"`
Sets the relative limit value in screen A for the power in the lower and upper second alternate adjacent channel to 30 dB below the channel power.

`"CALC:LIM:ACP:ALT2:ABS -35DBM, -35DBM"`
Sets the absolute limit value in screen A for the power in the lower and upper second alternate adjacent channel to -35 dBm.

`"CALC:LIM:ACP ON"`
Switches on globally the limit check for the channel/adjacent channel measurement in screen A.

`"CALC:LIM:ACP:ACH:REL:STAT ON"`
Switches on the check of the relative limit values for the alternate adjacent channels in screen A.

`"CALC:LIM:ACP:ACH:ABS:STAT ON"`
Switches on the check of absolute limit values for the alternate adjacent channels in screen A.

`"INIT;*WAI"`
Starts a new measurement and waits for the sweep end.

`"CALC:LIM:ACP:ACH:RES?"`
Queries the limit check result in the second alternate adjacent channels in screen A.

Features:

*RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:ABSolute -200DBM to 200DBM, -200DBM to .200DBM

This command defines the absolute limit value for the lower/upper alternate adjacent channel power measurement (Adjacent Channel Power) in the selected measurement window.

The numeric suffix after `ALTernate<1|2>` denotes the first or the second alternate channel. The numeric suffixes <1 to 8> are irrelevant for this command.

It should be noted that the absolute limit value for the limit check has no effect as soon as it is below the relative limit value defined with `CALCulate:LIMit:ACPower:ALTernate<1|2>:RELative`. This mechanism allows automatic checking of the absolute basic values defined in mobile radio standards for the power in adjacent channels.

Parameter: The first value is the limit for the lower and the upper alternate adjacent channel. The second limit value is ignored but should be indicated for reasons of compatibility with the FSE family.

Example: `"CALC:LIM:ACP:ALT2:ABS -35DBM, -35DBM"`
Sets the absolute limit value in screen A for the power in the lower and upper second alternate adjacent channel to -35 dBm.

Features: *RST value: -200DBM
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:ABSolute:STATe ON | OFF

This command activates the limit check for the first/second alternate adjacent channel in the selected measurement window for adjacent channel power measurement (Adjacent Channel Power).

Before the command, the limit check should be globally switched on for the channel/adjacent channel power with the command `CALCulate:LIMit:ACPower:STATe ON`.

The numeric suffix after `ALTernate<1|2>` denotes the first or the second alternate channel. The numeric suffixes <1 to 8> are irrelevant for this command.

The result can be queried with `CALCulate:LIMit:ACPower:ALTernate<1|2>:RESult?`. It should be noted that a complete measurement should be performed between switching on the limit check and the result query, since otherwise no valid results are obtained.

Example:

`"CALC:LIM:ACP:ALT2 30DB, 30DB"`
Sets the relative limit value in screen A for the power in the lower and upper second alternate adjacent channel to 30 dB below the channel power.

`"CALC:LIM:ACP:ALT2:ABS -35DBM, -35DBM"`
Sets the absolute limit value in screen A for the power in the lower and upper second alternate adjacent channel to -35 dBm.

`"CALC:LIM:ACP ON"`
Switches on globally the limit check for the channel/adjacent channel measurement in screen A.

`"CALC:LIM:ACP:ACH:REL:STAT ON"`
Switches on the check of the relative limit values for the alternative adjacent channels in screen A.

`"CALC:LIM:ACP:ACH:ABS:STAT ON"`
Switches on the check of absolute limit values for the alternative adjacent channels in screen A.

`"INIT;*WAI"`
Starts a new measurement and waits for the sweep end.

`"CALC:LIM:ACP:ACH:RES?"`
Queries the limit check result in the second alternate adjacent channels in screen A.

Features:

*RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:RESult?

This command queries the result of the limit check for the first/second alternate adjacent channel in the selected measurement window for adjacent channel power measurements.

The numeric suffix after `ALTernate<1|2>` denotes the first or the second alternate channel. The numeric suffixes <1 to 8> are irrelevant for this command.

If the power measurement of the adjacent channel is switched off, the command initiates a query error.

Parameter: The result is returned in the form <result>, <result> where <result> = PASSED | FAILED and where the first (second) returned value denotes the lower (upper) alternate adjacent channel.

Example:

`"CALC:LIM:ACP:ALT2 30DB, 30DB"`
Sets the relative limit value in screen A for the power in the lower and upper second alternate adjacent channel to 30 dB below the channel power.

`"CALC:LIM:ACP:ALT2:ABS -35DBM, -35DBM"`
Sets the absolute limit value in screen A for the power in the lower and upper second alternate adjacent channel to -35 dBm.

`"CALC:LIM:ACP ON"` Switches on globally the limit check for the channel/adjacent channel measurement in screen A.

`"CALC:LIM:ACP:ALT:STAT ON"`
Switches on the limit check for the adjacent channels in screen A.

`"INIT;*WAI"` Starts a new measurement and waits for the sweep end.

`"CALC:LIM:ACP:ALT:RES?"` Queries the limit check result in the second alternate adjacent channels in screen A.

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is a query and therefore not assigned an *RST value.

CALCulate:LIMit:CONTrol Subsystem

The CALCulate:LIMit:CONTrol subsystem defines the x-axis (CONTrol-axis).

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:LIMit<1 to 8>			
:CONTrol			
[:DATA]	<numeric_value>,<numeric_value>..	HZ | S	
:DOMain	FREQuency|TIME		
:OFFSet	<numeric_value>	HZ | S	
:MODE	RELative|ABSolute		
:SHIFt	<numeric_value>	HZ | S	

CALCulate<1|2>:LIMit<1 to 8>:CONTrol[:DATA] <numeric_value>,<numeric_value>..

This command defines the X-axis values (frequencies or times) of the upper or lower limit lines.The values are defined independently of the measurement window.

The number of values for the CONTrol axis and the corresponding UPPer and/or LOWer limit lines have to be identical. Otherwise default values are entered for missing values or out-of-limit values deleted.

The unit of values depends on the frequency or time domain of the X-axis, ie it is `HZ` with `CALC:LIM:CONT:DOM FREQ` und `S` bei `CALC:LIM:CONT:DOM TIME`.

Example: `"CALC:LIM2:CONT 1MHz,30MHz,100MHz, 300MHz,1GHz"`
Defines 5 reference values for the X-axis of limit line 2

`"CALC:LIM2:CONT?"` Outputs the reference values for the X-axis of limit line 2 separated by a comma.

Features: *RST value: - (LIMit:STATe is set to OFF)
SCPI: conforming

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:CONTrol:DOMain FREQuency | TIME

This command defines the X-axis in the frequency or time domain.

Example: `"CALC:LIM2:CONT:DOM TIME"` Defines the time domain for the X-axis of limit line 2.

Features: *RST value: FREQuency
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:CONTrol:OFFSet <numeric_value>

This command defines an offset for the X-axis value of the selected relative limit line in the frequency or time domain. The definition is independent of the measurement window.

The unit of values depends on the frequency or time domain of the X-axis, ie it is HZ with CALC:LIM:CONT:DOM FREQ und S bei CALC:LIM:CONT:DOM TIME.

Example: "CALC:LIM2:CONT:OFFS 100us" Sets the X offset for limit line 2 (defined in the time domain) to 100us.

Features: *RST value: 0
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:CONTrol:MODE RELative | ABSolute

This command selects the relative or absolute scaling for the X-axis of the selected limit line. The definition is independent of the measurement window.

Example: "CALC:LIM2:CONT:MODE REL" Defines the X-axis of limit line 2 as relative scaled.

Features: *RST value: ABSolute
SCPI: device-specific

Mode: A

Upon selection of RELative, the unit is switched to DB.

CALCulate<1|2>:LIMit<1 to 8>:CONTrol:SHIFt <numeric_value>

This command shifts a limit line by the indicated value in the x direction. In contrast to CALC:LIM:CONT:OFFS, the line is shifted by modifying the different x values and not by means of an additive offset. The shift is independent of the measurement window.

The unit of values depends on the frequency or time domain of the X-axis, ie it is HZ with CALC:LIM:CONT:DOM FREQ und S bei CALC:LIM:CONT:DOM TIME.

Example: "CALC:LIM2:CONT:SHIF 50KHZ" Shifts all reference values of limit line 2 by 50 kHz.

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate:LIMit:LOWer Subsystem

The CALCulate:LIMit:LOWer subsystem defines the lower limit line.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:LIMit<1 to 8>			
:LOWer			
[:DATA]	<numeric_value>,<numeric_value>..	DBM | DB | DEG | RAD | S | HZ | PCT	
:STATe	<Boolean>	--	
:OFFSet	<numeric_value>	DB| DEG| RAD| S | HZ | PCT	
:MARGin	<numeric_value>	DB| DEG| RAD| S | HZ | PCT	
:MODE	RELativeIABSolute	--	
:SHIFt	<numeric_value>	DB| DEG| RAD| S | HZ | PCT	
:THReshold	<numeric_value>	DBM | DB | DEG | RAD | S | HZ | PCT	

CALCulate<1|2>:LIMit<1 to 8>:LOWer[:DATA] <numeric_value>,<numeric_value>..

This command defines the values for the selected lower limit line independently of the measurement window.

The number of values for the CONTrol axis and the corresponding LOWer limit line have to be identical. Otherwise default values are entered for missing values or out-of-limit values deleted.

The unit must be identical with the unit selected by `CALC:LIM:UNIT`. If no unit is indicated, the unit defined with `CALC:LIM:UNIT` is automatically used.

If the measured values violate the LOWer limit line, the limit check signals errors.

Example: `"CALC:LIM:LOW -30,-40,-10,-40,-30"`
Defines 5 lower limit values for limit line 2 in the preset unit.

`"CALC:LIM2:LOW?"`
Outputs the lower limit values of limit line 2 separated by a comma.

Features: *RST value: - (LIMit:STATe is set to OFF)
SCPI: conforming

Mode: A

The units DEG, RAD, S, HZ, PCT are not available in the spectrum analysis mode.

CALCulate<1|2>:LIMit<1 to 8>:LOWer:STATe ON | OFF

This command switches on or off the indicated limit line in the selected measurement window. The limit check is activated separately with `CALC:LIM:STAT ON`.

Example: `"CALC:LIM4:LOW:STAT ON"` Switches on limit line 4 (lower limit) in screen A.

`"CALC2:LIM4:LOW:STAT ON"` Switches on limit line 4 (lower limit) also in screen B.

Example: `"CALC:LIM:LOWer:STAT ON"`

Features: *RST value: OFF
SCPI: conforming

Mode: A

The result of the limit check can be queried with `CALCulate:LIMit<1 to 8>:FAIL?`.

CALCulate<1|2>:LIMit<1 to 8>:LOWer:OFFSet <numeric_value>

This command defines an offset for the Y-axis of the selected relative lower limit line. In contrast to `CALC:LIM:LOW:SHIFt`, the line is not shifted by modifying the different Y values but by means of an additive offset. The offset is independent of the measurement window.

Example: `"CALC:LIM2:LOW:OFFS 3dB"` Shifts limit line 2 in the corresponding measurement windows by 3 dB upwards.

Features: *RST value: 0
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:LOWer:MARGin <numeric_value>

This command defines the margin of the selected lower limit line.

Example: `"CALC:LIM:LOW:MARG 10dB"`

Features: *RST value: 0
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:LOWer:MODE RELative | ABSolute

This command selects the relative or absolute scaling for the Y-axis of the selected lower limit line. The setting is independent of the measurement window.

Selecting RELative causes the unit to be switched to DB.

Example: `"CALC:LIM:LOW:MODE REL"` Defines the Y-axis of limit line 2 as relative scaled.

Features: *RST value: ABSolute
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:LOWer:SHIFt <numeric_value>

This command shifts a limit line by the indicated value in the Y-direction. In contrast to CALC:LIM:LOW:OFFS, the line is shifted by modifying the different Y values but not by means of an additive offset. The shift is independent of the measurement window.

Example: "CALC:LIM3:LOW:SHIF 20DB" Shifts all Y values of limit line 3 by 20 dB.

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:LIMit<1 to 8>:LOWer:THReshold <numeric_value>

This command defines an absolute threshold value for limit lines with relative Y-axis scaling independently of the measurement window. The absolute threshold value is used in the limit check as soon as it exceeds the relative limit value.

The unit should correspond to the unit selected with CALC:LIM:UNIT (except dB which is not permissible). If no unit is indicated, the unit defined with CALC:LIM:UNIT is automatically used (exception: dBm instead of dB).

Example: "CALC:LIM2:LOW:THR -35DBM" Defines an absolute threshold value for limit line 2.

Features: *RST value: -200 dBm
SCPI: device-specific

Mode: A

The units DEG, RAD, S, HZ, PCT are not available in the signal analysis mode.

CALCulate:LIMit:UPPer Subsystem

The CALCulate:LIMit:UPPer subsystem defines the upper limit line.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2> :LIMit<1 to 8> :UPPer			
[:DATA]	<numeric_value>,<numeric_value>..	DBM | DB | DEG | RAD | S | HZ | PCT	
:STATe	<Boolean>	--	
:OFFSet	<numeric_value>	DB| DEG| RAD| S | HZ | PCT	
:MARGin	<numeric_value>	DB| DEG| RAD| S | HZ | PCT	
:MODE	RELative|ABSolute	--	
:SHIFt	<numeric_value>	DB |DEG| RAD| S | HZ | PCT	
:THReshold	<numeric_value>	DBM | DB | DEG | RAD | S | HZ | PCT	

CALCulate<1\|2>:LIMit<1 to 8>:UPPer[:DATA] <numeric_value>,<numeric_value>..

This command defines the values for the upper limit lines independently of the measurement window.

The number of values for the CONTrol axis and the corresponding UPPer limit line have to be identical. Otherwise default values are entered for missing values or out-of-limit values deleted.

The unit must be identical with the unit selected by `CALC:LIM:UNIT`. If no unit is indicated, the unit defined with `CALC:LIM:UNIT` is automatically used.

If the measured values exceed the UPPer limit line, the limit check signals errors.

Example: `"CALC:LIM2:UPP -10,0,0,-10,-5"` Defines 5 upper limit values for limit line 2 in the preset unit.

`"CALC:LIM2:UPP?"` Outputs the upper limit values for limit line 2 separated by a comma.

Features: *RST value: - (LIMit:STATe is set to OFF)
SCPI: conforming

Mode: A

The units DEG, RAD, S, HZ, PCT are available in the vector signal analysis mode only.

CALCulate<1|2>:LIMit<1 to 8>:UPPer:STATe ON | OFF

This command switches on or off the indicated limit line in the selected measurement window. The limit check is activated separately with `CALC:LIM:STAT ON`. **Example:** `"CALC1:LIM4:UPP:STAT ON"` Switches on limit line 4 (upper limit) in screen A.

`"CALC2:LIM4:UPP:STAT ON"` Switches on limit line 4 (upper limit) in screen B.

Features: *RST value: OFF
SCPI: conforming

Mode: A

The result of the limit check can be queried with `CALCulate:LIMit<1 to 8>:FAIL?`.

CALCulate<1|2>:LIMit<1 to 8>:UPPer:OFFSet <numeric_value>

This command defines an offset for the Y-axis of the selected relative upper limit line. In contrast to `CALC:LIM:UPP:SHIFt`, the line is not shifted by modifying the different Y values but by means of an additive offset. The offset is independent of the measurement window.

Only the unit dB is available in the signal analysis mode.

Example: `"CALC:LIM2:UPP:OFFS 3dB"` Shifts limit line 2 by 3 dB upwards in the corresponding measurement windows.

Features: *RST value: 0
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:UPPer:MARGin <numeric_value>

This command defines a margin to one of the upper limit lines, at which out-of-limit values are signalled with the limit check activated, but which is not handled as a violation of the limit value. The margin is independent of the measurement window.

Only the unit dB is available in the signal analysis mode.

Example: `"CALC:LIM2:UPP:MARG 10dB"` Defines the margin of limit line 2 to 10 dB below the limit value.

Features: *RST value: 0
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:UPPer:MODE RELative | ABSolute

This command selects the relative or absolute scaling for the Y-axis of the selected upper limit line. The setting is independent of the measurement window.

Selecting RELative causes the unit to be switched to DB.

Example: `"CALC:LIM2:UPP:MODE REL"` Defines the Y-axis of limit line 2 as relative scaled.

Features: *RST value: ABSolute
SCPI: device-specific

Mode: A

CALCulate<1|2>:LIMit<1 to 8>:UPPer:SHIFt <numeric_value>

This command shifts a limit line by the indicated value in the Y-direction. In contrast to CALC:LIM:UPP:OFFS, the line is shifted by modifying the different Y values but not by means of an additive offset. The shift is independent of the measurement window.

Only the unit dB is available in the signal analysis mode.

Example: "CALC:LIM3:UPP:SHIF 20DB" Shifts all Y values of limit line 3 by 20 dB.

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:LIMit<1 to 8>:UPPer:THReshold <numeric_value>

This command defines an absolute threshold value for limit lines with relative Y-axis scaling independently of the measurement window. The absolute threshold value is used in the limit check as soon as it exceeds the relative limit value.

The unit should correspond to the unit selected with CALC:LIM:UNIT (except dB which is not permissible). If no unit is indicated, the unit defined with CALC:LIM:UNIT is automatically used (exception: dBm instead of dB).

Example: "CALC:LIM2:UPP:THR -35DBM" Defines an absolute threshold value for limit line 2.

Features: *RST value: -200 dBm
SCPI: device-specific

Mode: A

The units DEG, RAD, S, HZ, PCT are not available in the signal analysis mode.

CALCulate:MARKer Subsystem

The CALCulate:MARKer subsystem checks the marker functions in the instrument. The measurement windows are assigned to CALCulate 1 (screen A) or 2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:MARKer<1 to 4>			
[:STATe]	<Boolean>	--	
:AOFF			no query
:TRACe	<numeric_value>	--	
:X	<numeric_value>	HZ | S | DBM | DB	
:SLIMits			
[:STATe]	<Boolean>		
:LEFT	<numeric_value>	HZ | S	
:RIGHt	<numeric_value>	HZ | S	
:COUNt	<Boolean>	--	
:RESolution	<numeric_value>	HZ	
:FREQuency?	--	--	query only
:LOEXclude	<Boolean>		
:Y?	--	--	query only
:MAXimum			
[:PEAK]	--	--	no query
:NEXT	--	--	no query
:RIGHt	--	--	no query
:LEFT	--	--	no query
:MINimum			
[:PEAK]	--	--	no query
:NEXT	--	--	no query
:RIGHt	--	--	no query
:LEFT	--	--	no query
:PEXCursion	<numeric_value>	DB	

CALCulate<1\|2>:MARKer<1 to 4>[:STATe] ON | OFF

This command switches on or off the currently selected marker in the selected measurement window. If no indication is made, marker 1 is selected automatically. If marker 2, 3 or 4 is selected and used as delta marker, it is switched to marker mode.

Example: `"CALC:MARK3 ON"` Switches on marker 3 in screen A or to marker mode.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:AOFF

This command switches off all active markers in the selected measurement window. All delta markers and active marker/delta marker measurement functions are switched off.

Example: `"CALC:MARK:AOFF"` Switches off all markers in screen A.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:TRACe 1 to 3

This command assigns the selected marker (1 to 4) in the selected measurement window to the indicated test curve. The corresponding trace should be active, ie its status should be different from "BLANK".

The command first activates the corresponding marker, if necessary.

Example: `"CALC:MARK3:TRAC 2"` Assigns marker 3 in screen A to trace 2.

`"CALC2:MARK:TRAC 3"` Assigns marker 1 in screen B to trace 3.

Features: *RST value -
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:X 0 to MAX (frequency | sweep time)

This command positions the selected marker to the indicated frequency (span > 0), time (span = 0) or level (APD measurement or CCDF measurement ON) in the selected measurement window. If marker 2, 3 or 4 is selected and used as delta marker, it is switched to marker mode.

Example: `"CALC1:MARK2:X 10.7MHz"` Positions marker 2 in screen A to frequency 10.7 MHz.

Features: *RST value: -
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits[:STATe] ON | OFF

This command switches between a limited (ON) and unlimited (OFF) search range in the selected measurement window. The function is independent of the selection of a marker, ie the numeric suffix MARKer<1 to 4> is irrelevant.

If the time domain power measurement is active, this command limits the evaluation range to the trace.

Example: `"CALC:MARK:X:SLIM ON"` Switches on search limitation in screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits:LEFT 0 to MAX (frequency | sweep time)

This command sets the left limit of the search range for markers and delta markers in the selected measurement window to the indicated frequency (span > 0) or time (span = 0). The function is independent of the selection of a marker.

If the time domain power measurement is active, this command limits the evaluation range to the trace.

Example: `"CALC:MARK:X:SLIM:LEFT 10MHz"` Sets the left limit of the search range in screen A to 10 MHz.

Features: *RST value: - (is set to the left diagram edge on switching on search limits)
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits:RIGHT 0 to MAX (frequency | sweep time)

This command sets the right limit of the search range for markers and delta markers in the selected measurement window to the indicated frequency (span > 0) or time (span = 0). The function is independent of the selection of a marker, ie the numeric suffix in MARKer<1 to 4> is irrelevant.

If the time domain power measurement is active, this command limits the evaluation range to the trace.

Example: `"CALC:MARK:X:SLIM:RIGH 20MHz"` Sets the right limit of the search range in screen A to 20 MHz.

Features: *RST value: - (is set to the right diagram edge on switching on search limits)
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:COUNt ON | OFF

This command switches on or off the frequency counter at the marker position in the selected measurement window. The count result is queried with `CALCulate:MARKer:COUNt:FREQuency?`.

Frequency counting is possible only for one marker for each measurement window at a time. If it is activated for another marker, it is automatically de-activated for the previous marker.

It should be noted that a complete sweep should be performed after switching on the frequency counter to ensure that the frequency to be measured is actually reached. The synchronization to the sweep end required for this is possible only in the single-sweep mode.

Example:

`"INIT:CONT OFF"`	Switches to single-sweep mode.
`"CALC:MARK ON"`	Switches on marker 1 in screen A.
`"CALC:MARK:COUN ON"`	Switches on the frequency counter for marker 1.
`"INIT;*WAI"`	Starts a sweep and waits for the end.
`"CALC:MARK:COUN:FREQ?"`	Outputs the measured value in screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:COUNt:RESolution 0.1 | 1 | 10 | 100 | 1000 | 10000 Hz

This command specifies the resolution of the frequency counter in the selected measurement window.The setting is independent of the selected marker, ie the numeric suffix in MARKer<1 to 4> is irrelevant.

Example: `"CALC:MARK:COUN:RES 1kHz"` Sets the resolution of the frequency counter to 1 kHz.

Features: *RST value: 1kHz
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:COUNt:FREQuency?

This command queries the result of the frequency counter for the indicated marker in the selected measurement window. Before the command, the frequency counter should be switched on and a complete measurement performed to obtain a valid count result. Therefore, a single sweep with synchronization should be performed between switching on the frequency counter and querying the count result.

Example:

```
"INIT:CONT OFF"          Switches to single-sweep mode.
"CALC:MARK2 ON"          Switches marker 2 in screen A.
"CALC:MARK2:COUN ON"     Switches the frequency counter for marker 2.
"INIT;*WAI"              Starts a sweep and waits for the end.
"CALC:MARK2:COUN:FREQ?"  Outputs the measured value of delta marker 2 in
                         screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is only a query and thus has no *RST value.

CALCulate<1|2>:MARKer<1 to 4>:LOEXclude ON | OFF

This command switches the local oscillator suppression for peak search on or off. This setting is valid for all markers and delta markers in all measurement windows.

Example: "CALC:MARK:LOEX ON"

Features: *RST value: ON
SCPI: device-specific

Mode: A-F

The numeric suffixes 1|2 and 1 to 4 are irrelevant.

CALCulate<1|2>:MARKer<1 to 4>:Y?

This command queries the selected marker value in the selected measurement measurement window. The corresponding marker is first activated or switched to the marker mode, if necessary.

A complete sweep with synchronization to sweep end should be performed between switching on the marker and querying the y value to obtain a valid query result. This is only possible in the single-sweep mode.

The query result is output in the unit defined with CALCulate:UNIT.

Example:

```
"INIT:CONT OFF"   Switches to single-sweep mode.
"CALC:MARK2 ON"   Switches marker 2 in screen A.
"INIT;*WAI"       Starts a sweep and waits for the end.
"CALC:MARK2:Y?"   Outputs the measured value of marker 2 in screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:MAXimum[:PEAK]

This command positions the marker to the current maximum value in the trace memory of the selected measurement window. The corresponding marker is first activated or switched to the marker mode.

Note: *If no maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error eode: -200) is triggered.*

Example: `"CALC:MARK2:MAX"` Positions marker 2 in screen A to the maximum value of the trace.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:MAXimum:NEXT

This command positions the marker in the selected measurement window to the next smaller maximum value in the trace memory.

Note: *If no next smaller maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is triggered.*

Example: `"CALC:MARK2:MAX:NEXT"` Positions marker 2 in screen A to the next lower maximum value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:MAXimum:RIGHt

This command positions the marker in the selected measurement window to the next smaller maximum value to the right of the current value (ie in ascending X values) in the trace memory.

Note: *If no next smaller maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is triggered.*

Example: `"CALC:MARK2:MAX:RIGH"` Positions marker 2 in screen A to the next lower maximum value to the right of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:MAXimum:LEFT

This command positions the marker in the selected measurement window to the next smaller maximum value to the left of the current value (ie in descending X values) in the trace memory.

Note: *If no next smaller maximum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is triggered.*

Example: `"CALC:MARK2:MAX:LEFT"` Positions marker 2 in screen A to the next lowe maximum value to the left of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:MINimum[:PEAK]

This command positions the marker in the selected measurement curve to the current minimum value in the trace memory. The corresponding marker is first activated or switched to the marker mode, if necessary.

Note: *If no minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is triggered.*

Example: `"CALC:MARK2:MIN"` Positions marker 2 in screen A to the minimum value of the trace.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:MINimum:NEXT

This command positions the marker oin the selected measurement window to the next higher minimum value in the trace memory.

Note: *If no next higher minimum value is found on the trace (level spacing to adjacent values < peak excursion), an execution error (error code: -200) is triggered.*

Example: `"CALC:MARK2:MIN:NEXT"` Positions marker 2 in screen A to the next higher maximum value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:MINimum:RIGHt

This command positions the marker in the selected measurement window to the next higher minimum value to the right of the current value (ie in ascending X direction).

Note: *If no next higher minimum value is found on the trace (level spacing to* adjacent values *< peak excursion), an execution error (error code: -200) is triggered.*

Example: `"CALC:MARK2:MIN:RIGH"` Positions marker 2 in screen A to the next higher minimum value to the right of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:MINimum:LEFT

This command positions the marker in the selected measurement window to the next higher minimum value to the left of the current value (ie in descending X direction).

Note: *If no next higher minimum value is found on the trace (level spacing to* adjacent values *< peak excursion), an execution error (error code: -200) is triggered.*

Example: `"CALC:MARK2:MIN:LEFT"` Positions marker 2 in screen A to the next higher minimum value to the left of the current value.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:PEXCursion <numeric_value>

This command defines the peak excursion., ie the spacing below a trace maximum which should be attained before a new maximum is recognized or the spacing above a trace minimum which should be attained before a new minimum is recognized. The set value is valid for all markers and delta markers.

Example: `"CALC:MARK:PEXC 10dB"`

Features: *RST value: 6dB
SCPI: device-specific

Mode: A

The numeric suffix in MARKer<1 to 4> is irrelevant.

CALCulate:MARKer:FUNCtion Subsystem

The measurement windows are assigned to CALCulate 1 (screen A) or 2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:MARKer<1 to 4>			
:FUNCtion			
:NDBDown	<numeric_value>	DB	
:STATe	<Boolean>		
:RESult?	--	--	query only
:FREQuency?	--	--	query only
:ZOOM	<numeric_value>	HZ	no query
:NOISe			
[:STATe]	<Boolean>		
:RESult?	--	--	query only
:DEModulation			option audio demodulator
:SELect	AMIFM		
[:STATe]	<Boolean>		
:HOLDoff	<numeric_value>	S	
:MDEPth			
[:STATe]	<Boolean>		
:RESult?	--	--	query only
:TOI			
[:STATe]	<Boolean>		
:RESult?	--	--	query only
:CENTer			no query
:CSTep			no query
:REFerence			no query

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown <numeric_value>

This command defines the level spacing of the two delta markers to the right and left of marker 1 in the selected measurement window. Marker 1 is always used as the reference marker.

The temporary markers T1 and T2 are positioned by n dB below the active reference marker. The frequency spacing of these markers can be queried with `CALCulate:MARKer:FUNCtion:NDBDown:RESult?`.

Example: `"CALC:MARK:FUNC:NDBD 3dB"` Sets the level spacing in screen A to 3 dB.

Features: *RST value: 6dB
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown:STATe ON | OFF

This command switches the "N dB Down" function on or off. Marker 1 is first activated, if necessary.

Example: `"CALC:MARK:FUNC:NDBD:STAT ON"` Switches on the N-dB-down function in screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown:RESult?

This command queries the frequency spacing (bandwidth) of the N-dB-down markers in the selected measurement window.

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                 Switches to single-sweep mode.
"CALC:MARK:FUNC:NDBD ON"        Switches on the n-dB-down function in
                                screen A.
"INIT;*WAI"                     Starts a sweep and waits for the end.
"CALC:MARK:FUNC:NDBD:RES?"      Outputs the measured value of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is only a query and is therefore not assigned an *RST value.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown:FREQuency?

This command queries the two frequencies of the N-dB-down marker in the selected measurement window. The two frequency values are separated by comma and indicated in ascending order.

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                 Switches to single-sweep mode.
"CALC:MARK:FUNC:NDBD ON"        Switches on the n-dB-down function in
                                screen A.
"INIT;*WAI"                     Starts a sweep and waits for the end.
"CALC:MARK:FUNC:NDBD:FREQ?"     Outputs the frequencies of the temporary
                                markers in screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is only a query and is therefore not assigned an *RST value.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:ZOOM <numeric_value>

This command defines the range in the selected measurement window to be enlarged around marker 1. Marker 1 is first activated or switched to the marker mode, if necessary.

The subsequent frequency sweep is stopped at the marker position and the frequency of the signal is counted. This frequency becomes the new center frequency, the zoomed span is then set. To recognize the end of the operation the synchronization to the sweep end should be activated. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                 Switches to single-sweep mode
"CALC:MARK:FUNC:ZOOM 1kHz;*WAI" Activates zooming in screen A and
                                waits for its end.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-F

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NOISe[:STATe] ON | OFF

This command switches the noise measurement on or off for all markers of the indicated measurement window. The result can be queried with `CALCulate:MARKer:FUNCtion:NOISe:RESult?`.

Example: `"CALC2:MARK:FUNC:NOIS ON"` Switches on the noise measurement for screen B.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

The noise power density is measured at the position of the markers.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NOISe:RESult?

This command queries the result of the noise measurement. A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"          Switches to single-sweep mode.
"CALC:MARK2 ON"          Switches on marker 2 in screen A.
"CALC:MARK:FUNC:NOIS ON" Switches on noise measurement in screen A.
"INIT;*WAI"              Starts a sweep and waits for the end.
"CALC:MARK2:NOIS:RES?"   Outputs the noise result of marker 2 in
                         screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned an *RST value and has no query.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:DEModulation:SELect AM | FM

This command selects the demodulation type for the audio demodulator. The command is independent of the measurement window and of the selected marker, ie suffixes 1|2 and 1 to 4 are irrelevant. The command is only available with the audio demodulator option.

Example: `"CALC:MARK:FUNC:DEM:SEL FM"`

Features: *RST value: AM
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:DEModulation[:STATe] ON | OFF

This command switches on or off the demodulation when the indicated marker is attained in the selected measurement window. In the frequency domain (span > 0) the hold time can be defined at the corresponding marker position with `CALCulate:MARKer:FUNCtion:DEModulation:HOLD`. In the time domain (span = 0) the demodulation is permanently active.

The commande is only available with option audio demodulator.

Example: `"CALC2:MARK3:FUNC:DEM ON"` Switches on the demodulation for marker 3 in screen B.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:DEModulation:HOLDoff 10ms to 1000s

This command defines the hold time at the marker position for the demodulation in the frequency domain (span > 0). The setting is independent of the measurement window and the selected marker, ie the suffixes <1|2> and <1 to 4> are irrelevant

Example: "CALC:MARK:FUNC:DEM:HOLD 3s"

Features: *RST value: - (DEModulation is set to OFF)
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:MDEPth:[:STATe]

This command switches on the measurement of the AM modulation depth. An AM-modulated carrier is required on the screen for correct functioning. If necessary, marker 1 is previously activated and set to the largest signal available.

The level value of marker 1 is taken as the carrier level. On activating the function, marker 2 and marker 3 are automatically set to the adjacent maxima of the trace as delta markers symetrically to the carrier and marker 2 is activated for the entry.

If the position of delta marker 2 is changed, delta marker 3 is moved symetrically to the reference marker (marker 1). If the position of delta marker 3 is changed, fine adjustment can then be performed independently of delta marker 2.

FSP calculates the power at the marker positions from the measured levels. The AM modulation depth is calculated from the ratio of power values at the reference marker and the delta markers. If the two AM sidebands differ in power, the average value of the two power values is used for calculating the AM modulation depth.

The suffix <1 to 4> of :MARKer is irrelevant with this command.

Example:

"CALC:MARK:X 10MHZ"	Sets the reference marker (marker 1) to the carrier signal at 10 MHz
"CALC:MARK:FUNC:MDEP ON"	Switches on the modulation depth measurement in screen A.
"CALC:DELT2:X 10KHZ"	Sets delta markers 2 and 3 to the signals at 10 kHz from the carrier signal
"CALC:DELT3:X 9.999KHZ"	Corrects the position of delta marker 3 relative to delta marker 2.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:MDEPth:RESult?

This command queries the AM modulation depth in the indicated measurement window.

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

The suffix <1 to 4> of :MARKer is irrelevant in this command.

Example:

```
"INIT:CONT OFF"            Switches to single-sweep mode.
"CALC:MARK:X 10MHZ"        Sets the reference marker (marker 1) to
                           the carrier signal at 10 MHz.
"CALC:MARK:FUNC:MDEP ON"   Switches on the modulation depth
                           measurement in screen A.
"INIT;*WAI"                Starts a sweep and waits for the end.
"CALC:MARK:FUNC:MDEP:RES?" Outputs the measured value of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:TOI[:STATe] ON | OFF

This command initiates the measurement of the third-order intercept.

A two-tone signal with equal carrier levels is expected at the input of FSP. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Delta marker 3 and delta marker 4 are positioned to the intermodulation products. The delta markers can then be sperately modified with the commands `CALCulate:DELTamarker3:X` and `CALCulate:DELTamarker4:X`.

FSP calculates the third-order intercept from the level spacing between the normal markers and the delata markers.

The suffix <1 to 4> of :MARKer is irrelevant in this command.

Example:

```
"CALC:MARK:FUNC:TOI ON"    Switches on the measurement of the
                           third-order intercept in screen A.
```

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:TOI:RESult?

This command queries the intercept point measurement in the indicated measurement window.

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

The suffix <1 to 4> of :MARKer is irrelevant in this command.

Example:

```
"INIT:CONT OFF"          Switches to single-sweep mode.
"CALC:MARK:FUNC:TOI ON"  Switches the intercept measurement in
                         screen A.
"INIT;*WAI"              Starts a sweep and waits for the end.
"CALC:MARK:FUNC:TOI:RES?" Outputs the measured value of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:CENTer

This command sets the center frequency of the selected measurement window to that of the current marker.

If marker 2, 3 or 4 is selected and used as delta marker, it is switched to the marker mode.

Example:

```
"CALC:MARK2:FUNC:CENT"   Sets the center frequency of screen A to the
                         same value as the frequency of marker 2.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-F

This command is an "event" and therefore has no *RST value assigned and has no query.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:CSTep

This command sets the step width of the center frequency in the selected measurement window to the X value of the current marker. If marker 2, 3 or 4 is selected and used as delta marker, it is switched to the marker mode.

Example:

```
"CALC2:MARK3:FUNC:CST"   Sets the center frequency of screen B to the
                         same value as the frequency of marker 3.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-F

This command is an event and therefore has no *RST value assigned and has no query.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:REFerence

This command sets the reference level in the selected measurement window to that of the current marker. If marker 2, 3 or 4 is selected and used as delta marker, it is switched to the marker mode.

Example: `"CALC:MARK2:FUNC:REF"` Sets the reference level of screen A to the same value as the level of marker 2.

Features: *RST value: -
SCPI: device-specific

Mode: A

This command is an event and therefore has no *RST value assigned and has no query.

CALCulate:MARKer:FUNCtion:POWer Subsystem

The CALCulate:MARKer:FUNCtion:POWER subsystem contains the commands for control of power measurement.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:MARKer			
:FUNCtion			
:POWer			
:SELect	ACPower | CPOWer | OBANdwidth | OBWidth		
:RESult?	ACPower | CPOWer | OBANdwidth | OBWidthON | OFF		query only
:PHZ	<Boolean>		
:PRESet	NADC | TETRA | PDC | PHS | CDPD | FWCDma | RWCDma | F8CDma | R8CDma | F19Cdma | R19Cdma | NONE		
[:STATe]	OFF		no query

CALCulate<1\|2>:MARKer<1 to 4>:FUNCtion:POWer:SELect ACPower \| CPOWer \| OBANdwidth \| OBWidth

This command selects the power measurement and switches it on in the selected measurement window.. The function is independent of the selected marker, ie the suffix <1 to 4> of MARKer is irrelevant.

The configuration of channel spacings and channel bandwidths is performed by means of subsystem `SENSe:POWer:ACHannel`.

It should be noted that selecting CPOWer causes the number of adjacent channels (command: `[SENSe<1|2>:]POWer:ACHannel:ACPairs`) to be set to 0. Selecting ACPower causes the number of adjacent channels to be set to 1, if the adjacent channel power measurement is not yet switched on. In both cases the behaviour of FSP differs from that of the FSE family.

Note: *The measurement of the channel/adjacent channel power is performed on the trace which has been selected with `SENSe:POWer:TRACe 1|2|3`.*

The measurement of the occupied bandwidth is performed on the trace on which marker 1 is positioned. To evaluate another trace, marker 1 should be positioned on another trace with `CALC:MARK:TRAC 1|2|3`.

Parameter:

ACPower	adjacent channel power measurement
CPOWer	channel power measurement (same as adjacent channel power measurement with No. of Adj Channels = 0)
OBANdwidth | OBWidth	occupied bandwidth power measurement

Example: `"CALC:MARK:FUNC:POW:SEL ACP"` Switches on the adjacent channel power measurement in screen A.

Features: *RST value: -
SCPI: device-specific

Mode: A-F

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:RESult? ACPower | CPOWer | OBANdwidth | OBWidth

This command queries the results of the occupied bandwidth power measurement in the selected measurement window.

Parameter:

ACPower: adjacent channel power measurement

Results are output separated by commas in the following order:

1. Power of main channel
2. Power of lower adjacent channel
3. Power of upper adjacent channel
4. Power of lower alternate adjacent channel 1
5. Power of upper alternate adjacent channel 1
6. Power of lower alternate adjacent channel 2
7. Power of upper alternate adjacent channel 2

The number of results depends on the number of adjacent channels selected with command `SENSe:POWer:ACHannel:ACPairs`.

With logarithmic scaling (RANGE LOG), the power is output in dBm, with linear scaling (RANGE LIN dB or LIN %) in W. If SENSe:POWer:ACHannel:MODE REL is selected, adjacent channel power is output in dB.

CPOWer channel power measurement

With logarithmic scaling (RANGE LOG), the channel power is output in dBm, with linear scaling (RANGE LIN dB or LIN %) in W.

OBANdwidth | OBWidth occupied bandwidth power measurement

The return value is the occupied bandwidth in Hz.

Example of channel/adjacent power measurement:

`"SENS2:POW:ACH:ACP 3"`	Sets the number of adjacent channels in screen B to 3.
`"SENS2:POW:ACH:BAND 30KHZ"`	Sets the bandwidth of the main channel to 30 kHz.
`"SENS2:POW:ACH:BAND:ACH 40KHZ"`	Sets the bandwidth of all adjacent channels to 40 kHz.
`"SENS2:POW:ACH:BAND:ALT1 50KHZ"`	Sets the bandwidth of all alternate adjacent channels to 50 kHz.
`"SENS2:POW:ACH:BAND:ALT2 60KHZ"`	Sets the bandwidth of alternate adjacent channel 2 to 60 kHz.
`"SENS2:POW:ACH:SPAC 30KHZ"`	Sets the spacing between channel to adjacent channel to 30 kHz as well as between channel and alternate adjacent channel to 60 kHz and 2nd alternate adjacent channel to 90 kHz.
`"SENS2:POW:ACH:SPAC:ALT1 100KHZ"`	Sets the spacing between channel and alternate adjacent channel to 100 kHz as well as 2nd alternate adjacent channel to 150 kHz.
`"SENS2:POW:ACH:SPAC:ALT2 140KHZ"`	Sets the spacing between channel and alternate adjacent channel 2 to 140 kHz.
`"SENS2:POW:ACH:MODE ABS"`	Switches on the measurement of absolute power values.
`"CALC2:MARK:FUNC:POW:SEL ACP"`	Switches the adjacent channel power measurement in screen B.

```
"INIT:CONT OFF"                          Switches to single-sweep mode.
"INIT;*WAI"                              Starts a sweep and waits for the end
"CALC2:MARK:FUNC:POW:RES? ACP"           Queries the result of the adjacent channel
                                         power measurement in screen B.
                                         In case of relative measurement, the
                                         measured channel power can be defined as
                                         the reference power with command.
"SENS2:POW:ACH:REF:AUTO ONCE".
```

If the **channel power** is to be measured separately, all commands for defining the bandwiths of adjacent channels as well as the channel spacings are not necessary. The number of adjacent channels is set to 0 with `SENS2:POW:ACH:ACP 0`.

Example of occupied bandwidth measurement:

```
"SENS2:POW:BAND 90PCT"                   Sets the percentage of the power contained in
                                         the searched bandwidth to 90%.
"INIT:CONT OFF"                          Switches to single-sweep mode.
"INIT;*WAI"                              Starts a sweep and waits for the end.
"CALC2:MARK:FUNC:POW:RES? OBW"           Queries the result of the occupied bandwidth
                                         in screen B.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-F

This command is only a query and is therefore not assigned an *RST value.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:RESult:PHZ ON | OFF

This command switches the query of the power measurement results in the indicated measurement window between output of absolute values (OFF) and output referred to the measurement bandwith (ON)..

The configuration of channel spacings and channel bandwidths is performed with subsytem `SENSe:POWer:ACHannel`.

The measurement results are output with `CALCulate:MARKer:FUNCtion:POWer:RESult?`

Parameter:

ON: Results output referred to measurement bandwidth.

OFF: Results output in absolute values.

Example of channel/adjacent channel measurement:

`"SENS2:POW:ACH:ACP 3"`	Sets the number of adjacent channels in screen B to 3.
`"SENS2:POW:ACH:BAND 30KHZ"`	Sets the bandwidth of the main channel to 30 kHz.
`"SENS2:POW:ACH:BAND:ACH 40KHZ"`	Sets the bandwidth of all adjacent channels to 40 kHz.
`"SENS2:POW:ACH:BAND:ALT1 50KHZ"`	Sets the bandwidth of all alternate adjacent channels to 50 kHz.
`"SENS2:POW:ACH:BAND:ALT2 60KHZ"`	Sets the bandwidth of alternate adjacent channel 2 to 60 kHz.
`"SENS2:POW:ACH:SPAC 30KHZ"`	Sets the spacing between channel and adjacent channel as well as between all adjacent channels to 30 kHz.
`"SENS2:POW:ACH:SPAC:ALT1 40KHZ"`	Sets the spacing between adjacent channel and alternate adjacent channel as well as between all alternate adjacent channels to 40 kHz.
`"SENS2:POW:ACH:SPAC:ALT2 50KHZ"`	Sets the spacing between alternate adjacent channel 1 and alternate adjacent channel 2 to 50 kHz.
`"SENS2:POW:ACH:MODE ABS"`	Switches on absolute power measurement.
`"CALC2:MARK:FUNC:POW:SEL ACP"`	Switches the adjacent channel power measurement in screen B.
`"INIT:CONT OFF"`	Switches to single-sweep mode.
`"INIT;*WAI"`	Starts a sweep and waits for the end.
`"CALC2:MARK:FUNC:POW:RES:PHZ ON"`	Output of results referred to the channel bandwidth.
`"CALC2:MARK:FUNC:POW:RES? ACP"`	Queries the result of the adjacent channel power measurement in screen B referred to the channel bandwidth.

If the **channel power** is to be measured separately, all commands for defining the bandwiths of adjacent channels as well as the channel spacings are not necessary. The number of adjacent channels is set to 0 with `SENS2:POW:ACH:ACP 0`.

Features: *RST value: -
SCPI: device-specific

Mode: A-F

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer[:STATe] OFF

This command switches off the power measurement in the selected measurement window.

Example: "CALC:MARK:FUNC:POW OFF" Switches off the power measurement in screen B.

Features: *RST value: -
SCPI: device-specific

Mode: A-F

This command is an event and is therefore not assigned an *RST value.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:PRESet NADC | TETRA | PDC | PHS | CDPD | FWCDma | RWCDma | F8CDma | R8CDma | F19Cdma | R19Cdma | NONE

This command selects the power measurement setting for a standard in the indicated measurement window and switches on first the corresponding measurement, if required. The function is independent of the marker selection, ie the suffix <1 to 4> of MARKer is irrelevant.

The selection of a standard influences the parameters weighting filter, channel bandwidth and spacing, resolution and video bandwidth, as well as detector and sweep time.

Designation of CDMA standard:

FWCDma	W-CDMA
RWCDma	W-CDMA
F8CDma	CDMA IS95A forward
R8CDma	CDMA IS95A reverse
F19CDma	CDMA J-STD008 forward
R19CDma	CDMA J-STD008 reverse

Example: "CALC2:MARK:FUNC:POW:PRES NADC" selects the standard setting for NADC in screen B

Features: *RST value: -
SCPI: device-specific

Mode: A-F

CALCulate:MARKer:FUNCtion:STRack Subsystem

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:MARKer			
:FUNCtion			
:STRack			
[:STATe]	<Boolean>		
:BANDwidth	<numeric_value>	HZ	
:BWIDth	<numeric_value>	HZ	
:THReshold	<numeric_value>	DBM	
:TRACe	<numeric_value>		

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack[:STATe] ON | OFF

This command switches the signal-track on or off for the the selected measurement window. The function is independent of the selected marker, ie the suffix <1 to 4> of MARKer is irrelevant.

With signal track activated, the maximum signal is determined after each frequency sweep and the center frequency of this signal is set. With drifting signals the center frequency follows the signal.

Example: `"CALC:MARK:FUNC:STR ON"` Switches on the signal track function for screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A-F

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack:BANDwidth|BWIDth 10 Hz to MAX (SPAN)

These commands have the same function and define the bandwidth at the center frequency within which the largest signal is searched for in the selected measurement window. The function is independent of the selected marker, ie the suffix <1 to 4> of MARKer is irrelevant. It is only available in the frequency domain (span > 0).

Example: `"CALC:MARK:FUNC:STR:BAND 1MHZ"` Sets the search bandwidth for screen A to 1 MHz.

`"CALC:MARK:FUNC:STR:BWID 1MHZ"` Alternative command for the same function.

Features: *RST value: -- (= span/10 on activating the function)
SCPI: device-specific

Mode: A-F

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack:THReshold -330 dBm to +30 dBm

This command defines the threshold above which the largest signal is searched for in the selected measurement window. The function is independent of the selected marker, ie the suffix <1 to 4> of MARKer is irrelevant. It is only available in the frequency domain (span > 0)..

The unit depends on the setting performed with `CALC:UNIT`.

Example: `"CALC:MARK:FUNC:STR:THR -50DBM"` Sets the threshold for signal tracking in screen A to -50 dBm.

Features: *RST value: -120 dBm
SCPI: device-specific

Mode: A-F

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack:TRACe 1 to 3

This command defines the trace on which the largest signal is searched for in the selected measurement window. The function is independent of the selected marker, ie the suffix <1 to 4> of MARKer is irrelevant. It is only available in the frequency domain (span > 0).

Example: `"CALC2:MARK:FUNC:STR:TRAC 3"` Defines trace 3 in screen B as the trace for signal tracking.

Features: *RST value: 1
SCPI: device-specific

Mode: A-F

CALCulate:MARKer:FUNCtion:SUMMary Subsystem

This subsystem contains the commands for controlling the time domain power functions. These are provided in the marker subsytem for reasons of compatibility with the FSE family.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:MARKer			
:FUNCtion			
:SUMMary			
[:STATE]	<Boolean>		
:PPEak			
[:STATe]	<Boolean>		
:RESult?			query only
:AVERage			
:RESult?			query only
:PHOLd			
:RESult?			query only
:RMS			
[:STATe]	<Boolean>		
:RESult?			query only
:AVERage			
:RESult?			query only
:PHOLd			
:RESult?			query only
:MEAN			
[:STATe]	<Boolean>		
:RESult?			query only
:AVERage			
:RESult?			query only
:PHOLd			
:RESult?			query only
:SDEViation			
[:STATe]	<Boolean>		
:RESult?			query only
:PHOLd	<Boolean>		
:AVERage	<Boolean>		
:MODE	ABSolute|RELative		
:REFerence			
:AUTO	ONCE		
:AOFF			no query

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:STATe ON | OFF

This command switches on or off the last active time domain power measurements. Thus one or several measurements can be first selected and then switched on and off together with `CALC:MARK:FUNC:SUMMary:STATe`.

The function is independent of the marker selection, ie the suffix of MARKer is irrelevant. It is only available in the time domain (span = 0).

Example: `"CALC:MARK:FUNC:SUMM:STAT ON"`

Features: *RST value: OFF
SCPI: device-specific

Mode: A-Z

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak[:STATe] ON | OFF

This command switches on or off the measurement of the positive peak value in the selected measurement window. The function is independent of the marker selection, ie the suffix <1 to 4> of MARKer is irrelevant. It is only available in the time domain (span = 0).

Example: `"CALC:MARK:FUNC:SUMM:PPE ON"` Switches on the function in screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A-Z

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak:RESult?

This command is used to query the result of the measurement of the positive peak value in the selected measurement window. The measurement may have to be switched on previously. The function is independent of the marker selection, ie the suffix <1 to 4> of MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:PPE ON"       Switches on the function in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:PPE:RES?"     Outputs the result of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak:AVERage:RESult?

This command is used to query the result of the measurement of the positive peak value in the selected measurement window with the average calculated using the command `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion: SUMMary:AVERage`. The function is independent of the marker selection, ie the suffix <1 to 4> in MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:PPE ON"       Switches on the function in screen A.
"CALC:MARK:FUNC:SUMM:AVER ON"      Switches on the calculation of average
                                   in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:PPE:AVER:RES?"  Outputs the result of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak:PHOLd:RESult?

This command is used to query the result of the measurement of the positive peak value with the peak hold function switched on with command `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PHOLd`. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:PPE ON"       Switches on the function in screen A.
"CALC:MARK:FUNC:SUMM:PHOL ON"      Switches on the measurement of the
                                   peak value in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:PPE:PHOL:RES?" Outputs the result of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS[:STATe] ON | OFF

This command switches on or off the measurement of the effective (rms) value of the total trace in the selected measurement window. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

Example:

```
"CALC2:MARK:FUNC:SUM:RMS ON"  Switches on the function in screen B.
```

Features: *RST value: OFF
SCPI: device-specific

Mode: A-Z

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS:RESult?

This command queries the result of the measurement of the rms value of the total trace in the selected measurement window. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:RMS ON"       Switches on the function in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:RMS:RES?"     Outputs the result of screen A.
```

Features: *RST- value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS:AVERage:RESult?

This command queries the result of the measurement of the rms value of the total trace in the selected measurement window with the average calculated using the command `CALCulate<1|2>:MARKer<1 to 4>:FUNCtion: SUMMary:AVERage`. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:RMS ON"       Switches on the function in screen A.
"CALC:MARK:FUNC:SUMM:AVER ON"      Swtiches on the average value
                                   calculation in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:RMS:AVER:RES?" Outputs the result of screen A.
```

Features: *RST- value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS:PHOLd:RESult?

This command queries the result of the measurement of the rms value of the total trace in the selected measurement window with the peak hold function switched on using the command `CALCulate<1|2>:MARKer<1 to 4>: FUNCtion:SUMMary:PHOLd`. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:RMS ON"       Switches on the function in screen A.
"CALC:MARK:FUNC:SUMM:PHOL ON"      Switches on the peak value
                                   measurement in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:RMS:PHOL:RES?" Outputs the result of screen A.
```

Features: *RST- value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN[:STATe] ON | OFF

This command switches on or off the measurement of the mean value of the total trace in the selected measurement window. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0)..

Note: *The measurement is performed on the trace on which marker 1 is positioned. To evaluate another trace, marker 1 should be positioned on another trace with CALC:MARK:TRAC 1|2|3.*

Example: "CALC:MARK:FUNC:SUMM:MEAN ON" Switches on the function in screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A-Z

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN:RESult?

This command queries the result of the measurement of the mean value of the total trace in the selected measurement window. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:
```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:MEAN ON"      Switches on the function in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:MEAN:RES?"    Outputs the result of screen A.
```

Features: *RST- value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN:AVERage:RESult?

This command queries the result of the measurement of the mean value of the total trace in the selected measurement window with the average calculated using the command CALCulate<1|2>:MARKer<1 to 4>:FUNCtion: SUMMary:AVERage. The query is possible only if the average calculation is active. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:
```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:MEAN ON"      Switches on the function in screen A.
"CALC:MARK:FUNC:SUMM:AVER ON"      Switches on the average value
                                   calculation in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:MEAN:AVER:RES?" Outputs the result of screen A.
```

Features: *RST- value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?

This command queries the result of the measurement of the mean value of the total trace in the selected measurement window with the peak hold function switched on using the command `CALCulate<1|2>:MARKer<1 to 4>: FUNCtion:SUMMary:PHOLd`. The query is possible only if the peak hold function is active. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode
"CALC:MARK:FUNC:SUMM:MEAN ON"      Switches on the function in screen A
"CALC:MARK:FUNC:SUMM:PHOL ON"      Switches on the peak value
                                   measurement in screen A
"INIT;*WAI"                        Starts a sweep and waits for the end
"CALC:MARK:FUNC:SUMM:MEAN:PHOL:RES?" Outputs the result of screen A.
```

Features: *RST- value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation[:STATe] ON | OFF

This command switches on or off the measurement of the standard deviation of the total trace in the selected measurement window.The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0)..

On switching on the measurement, the mean power measurement is switched on as well.

Example:

```
"CALC2:MARK:FUNC:SUMM:SDEV ON"     Switches on the measurement of
                                   the standard deviation in screen B.
```

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation:RESult?

This command queries the results of the standard deviation measurement. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:SDEV ON"      Switches on the function in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:SDEV:RES?"    Outputs the result of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation:AVERage:RESult?

This command queries the result of the standard deviation determined in several sweeps in the selected measurement window. The query is possible only if the calculation of average is active. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:SDEV ON"      Switches on the function in screen A.
"CALC:MARK:FUNC:SUMM:AVER ON"      Switches on the calculation of average
                                   in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:MEAN:SDEV:RES?" Outputs the result of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?

This command queries the maximum standard deviation value determined in several sweeps in the selected measurement window. The query is possible only if the peak hold function is active. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0).

A complete sweep with synchronization to sweep end should be performed between switching on the function and querying the measured value to obtain a valid query result. This is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                    Switches to single-sweep mode.
"CALC:MARK:FUNC:SUMM:SDEV ON"      Switches on the function in screen A.
"CALC:MARK:FUNC:SUMM:PHOL ON"      Switches on the peak value
                                   measurement in screen A.
"INIT;*WAI"                        Starts a sweep and waits for the end.
"CALC:MARK:FUNC:SUMM:SDEV:PHOL:RES?" Outputs the result of screen A.
```

Features: *RST value: -
SCPI: device-specific

Mode: A-Z

This command is only a query and thus has no *RST value assigned.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PHOLd ON | OFF

This command switches on or off the peak-hold function for the active time domain power measurement in the indicated measurement window. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0).

The peak-hold function is reset by switching off and on again.

Example: "CALC:MARK:FUNC:SUMM:PHOL ON" Switches on the function in screen A.

Features: *RST value: OFF
SCPI: device-specific

Mode: A-Z

The peak-hold function is reset by switching off and on, again.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:AVERage ON | OFF

This command switches on or off the the calculation of average for the active time domain power measurement in the indicated window. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0).

Averaging is reset by switching off and on again.

The number of results required for the calculation of average is defined with [SENSe<1|2>:]AVERage:COUNt.

It should be noted that synchronizing to the end of averaging is only possible in the single-sweep mode.

Example:

```
"INIT:CONT OFF"                  Switches to single-sweep mode.
"CALC2:MARK:FUNC:SUMM:AVER ON"   Switches on the calculation of average
                                 in screen B.
"AVER:COUN 200"                  Sets the measurement counter to 200.
"INIT;*WAI"                      Starts a sweep and waits for the end.
```

Features: *RST value: OFF
SCPI: device-specific

Mode: A-Z

The calculation of the average is reset by switching off and on again.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MODE ABSolute | RELative

This command switches between absolute and relative time domain power measurement in the indicated measurement window. The function is independent of the marker selection, ie the suffix <1 to 4> of :MARKer is irrelevant. It is only available in the time domain (span = 0).

The reference power for relative measurement is defined with CALCulate:MARKer:FUNCtion :SUMMary:REFerence:AUTO ONCE. If the reference power is not defined, the value 0 is used.

Example: "CALC:MARK:FUNC:SUMM:REF:MODE REL"
Switches the time domain power measurement to relative.

Features: *RST value: ABSolute
SCPI: device-specific

Mode: A-Z

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:REFerence:AUTO ONCE

With this command the power values currently measured by means of the calculation of the average (`...:SUMMary:MEAN`) and of the rms value (`...:SUMMary:RMS`) are declared as reference values for relative measurements in the indicated measurement window. The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

If the measurement of rms value and average is not activated, the reference value 0 dBm is used.

If the function `...:SUMMary:AVERage` or `...:SUMMary:PHOLd` is switched on, the current value is the measured value summed at the time considered.

Example: `"CALC:MARK:FUNC:SUMM:REF:AUTO ONCE"`
Takes the currently measured power in screen A as reference value for the relative time domain power measurement.

Features: *RST value: -
SCPI: device-specific

Mode: A-Z

This command is an event and therefore has no *RST value assigned and has no query.

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:AOFF

This command switches off all time domain measurements in the selected measurement window.The function is independent of the marker selection, ie the suffix `<1 to 4>` of `:MARKer` is irrelevant. It is only available in the time domain (span = 0).

Example: `"CALC2:MARK:FUNC:SUMM:AOFF"` Switches off the time domain power measurement functions in screen B.

Features: *RST value: _
SCPI: device-specific

Mode: A-Z

This command is an event and therefore has no *RST value assigned and has no query.

CALCulate:MATH Subsystem

The CALCulate:MATH subsystem allows to process data from the SENSe-subsystem in numeric expressions. The measurement windows are assigned to CALCulate1 (screen A) or CALCulate2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2>			
:MATH			
[:EXPRession]			
[:DEFine]	<expr>	--	
:POSition	<numeric_value>	PCT	
:STATe	<Boolean>	--	
:MODE	LINear | LOGarithmic	--	

CALCulate<1|2>:MATH[:EXPression][:DEFine] <expr>

This command defines the mathematical expression for relating traces and trace1.

The zero point of the result display can be defined with `CALC:MATH:POS`. Command `CALCulate:MATH:STATe` switches the mathematical relation of traces on or off .

Parameter: <expr>::= 'OP1 - OP2'
OP1 ::= TRACE1
OP2 ::= TRACE2 | TRACE3

Example:

```
"CALC1:MATH (TRACE1 - TRACE2)"
```
Selects the subtraction of trace 1 from trace 2 in screen A.

```
"CALC2:MATH (TRACE1 - TRACE3)"
```
Selects the subtraction of trace 1 from trace 3 in screen B.

Features: *RST value: -
SCPI: conforming

Mode: A

CALCulate<1|2>:MATH:POSition -100PCT to 200PCT

This command defines the position of the result of the trace mathematics in the selected measurement window. The indication is in % of the screen height, 100% corresponding to the upper diagram edge.

Example:

```
"CALC:MATH:POS 50PCT"
```
Sets the position in screen A to the horizontal diagram center.

Features: *RST value: 50 %
SCPI: device-specific

Mode: A

CALCulate<1|2>:MATH:STATe ON | OFF

This command switches the mathematical relation of traces on or off.

Example:	"CALC:MATH:STAT ON"	Switches on the trace mathematics in screen A.
Features:	*RST value: OFF SCPI: conforming	
Mode:	A	

CALCulate<1|2>:MATH:MODE LINear | LOGarithmic

This command selects linear or logarithmic (= video) calculation of the mathematical functions related to the traces. The calculation of the average is one of such functions. The setting is valid for all measurement windows, ie the suffix <1 | 2> of CALCulate is irrelevant.

Example:	"CALC:MATH:MODE LIN"	Switches on the linear calculation.
Features:	*RST value: LOG SCPI: device-specific	
Mode:	A	

CALCulate:STATistics Subsystem

The CALCulate:STATistics subsystem controls the statistical measurement functions in the instrument. The measurement window cannot be selected with these functions. The numeric suffix in CALCulate is therefore ignored.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate			
:STATistics			
:APD			
[:STATe]	<Boolean>	--	
:CCDF			
[:STATe]	<Boolean>	--	
:NSAMples	<numeric_value>		
:SCALe			
:AUTO	ONCE		
:X			
:RLEVel	<numeric_value>	DBM	
:RANGe	<numeric_value>	DB	
:Y			
:UPPer	<numeric_value>		
:LOWer	<numeric_value>		
:PRESet			
:RESult<13>?	MEAN | PEAK | CFACtor | ALL		query only

CALCulate:STATistics:APD[:STATe] ON | OFF

This command switches on or off the measurement of amplitude distribution (APD). On activating this function, the CCDF measurement is switched off.

Example: "CALC:STAT:APD ON" Switches on the APD measurement.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate:STATistics:CCDF[:STATe] ON | OFF

This command switches on or off the measurement of the complementary cumulative distribution function (CCDF). On activating this function, the APD mesurement is switched off.

Example: "CALC:STAT:CCDF ON" Switches on the CCDF measurement.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate:STATistics:NSAMples 100 to 1E9

This command sets the number of test points to be recorded for the statistical measurement functions.

Example: "CALC:STAT:NSAM 500" Sets the number of test points to be recorded to 500.

Features: *RST value: 100
SCPI: device-specific

Mode: A

CALCulate:STATistics:SCALe:AUTO ONCE

This command optimizes the level setting of FSP depending on the measured peak power to obtain maximum instrument sensitivity.

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power with the APD measurement and of the spacing between the peak power and the mean power with CCDF measurement. In addition, the probability scale for the number of test points is adapted.

Example: "CALC:STAT:SCAL:AUTO ONCE" Adapts the level setting for statistical measurements.

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is an event and therefore has no *RST value assigned and has no query.

CALCulate:STATistics:X:RLEVel -130dBm to 30dBm

This command defines the reference level for the X-axis of the measurement diagram. The setting is identical to the reference level setting using the command DISPlay:WINDow:TRACe:Y:RLEVel.

With the reference level offset <> 0 the indicated value range of the reference level is modified by the offset.

The unit depends on the setting performed with CALC:UNIT.

Example: "CALC:STAT:X:RLEV -60dBm"

Features: *RST value: -20dBm
SCPI: device-specific

Mode: A

CALCulate:STATistics:X:RANGe 10dB to 200dB

This command defines the level range for the X-axis of the measurement diagram. The setting is identical to the level range setting defined with the command DISPlay:WINDow:TRACe:Y:SCALe.

Example: "CALC:STAT:X:RANG 20dB"

Features: *RST value: 100dB
SCPI: device-specific

Mode: A

CALCulate:STATistics:Y:UPPer 1E-8 to 1.0

This command defines the upper limit for the Y-axis of the diagram in statitistical measurements. Since probabilities are specified on the Y-axis, the entered numerical values are dimensionless.

Example: "CALC:STAT:Y:UPP 0.01"

Features: *RST value: 1.0
SCPI: device-specific

Mode: A

CALCulate:STATistics:Y:LOWer 1E-9 to 0.1

This command defines the lower limit for th Y-axis of the diagram in statistical measurements. Since probabilities are specified on the Y-axis, the entered numerical values are dimensionless.

Example: "CALC:STAT:Y:LOW 0.001"

Features: *RST value: 1E-6
SCPI: device-specific

Mode: A

CALCulate:STATistics:PRESet

This command resets the scaling of the X- and Y-axes in a statistical measurement. The following values are set:

X-axis ref level: -20 dBm
X-axis range APD: 100 dB
X-axis range CCDF: 20 dB

Y-axis upper limit: 1.0
Y-axis lower limit: 1E-6

Example: "CALC:STAT:PRES" Resets the scaling for statistical functions

Features: *RST value: --
SCPI: device-specific

Mode: A

This command is an event and therefore has no *RST value assigned and has no query.

CALCulate:STATistics:RESult<1 to 3>? MEAN|PEAK|CFACtor|ALL

This command reads out the results of statistical measurements of a recorded trace. The trace is selected with the numeric suffix <1 to 3>. The required result is selected via the following parameters:

MEAN	Average power in dBm measured over the measurement time.
PEAK	Peak power in dBm measured over the measurement time.
CFACtor	Determined CREST factor (= ratio of peak power to average power) in dB.
ALL	Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

Example: `"CALC:STAT:RES2? ALL"` Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69
ie mean power: 5.56 dBm, peak power 19.25 dBm, CREST factor 13.69 dB

Features: *RST value: --
SCPI: device-specific

Mode: A

CALCulate:THReshold Subsystem

The CALCulate:THReshold subsystem controls the threshold value for the maximum/minimum search of markers. The measurement windows are assigned to CALCulate 1 (screen A) or 2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2> :THReshold :STATe	<numeric_value> <Boolean>	DBM | DB	

CALCulate<1|2>:THReshold MINimum to MAXimum (depending on current unit)

This command defines the threshold value for the maximum/minimum search of markers with marker search functions MAX PEAK, NEXT PEAK, etc. in the selected measurement window. The associated display line is automatically switched on.

Example: "CALC:THR -82DBM" Sets the threshold value for screen A to -82 dBm.

Example: "CALC:THR -82dBm"

Features: *RST value: - (STATe to OFF)
SCPI: device-specific

Mode: A

CALCulate<1|2>:THReshold:STATe ON | OFF

This command switches on or off the threshold line in the selected measurement window.The unit depends on the setting performed with CALC:UNIT.

Example: "CALC2:THR:STAT ON" Switches on the threshold line in screen B.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

CALCulate:UNIT Subsystem

The CALCulate:Unit subsystem defines the units for power measurements.

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1|2> :UNIT :POWer	DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere		

CALCulate<1|2>:UNIT:POWer DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

This command selects the unit for power in the selected measurement window.

Example: `"CALC:UNIT:POW DBM"` Sets the power unit for screen A to dBm.

Features: *RST value: _
SCPI: device-specific

Mode: A

CALibration Subsystem

The commands of the CALibration subsystem determine the data for system error correction in the instrument.

COMMAND	PARAMETERS	UNIT	COMMENT
CALibration			
[:ALL]?	--	--	query only
:ABORt	--	--	no query
:RESult?	--	--	query only
:STATe	<Boolean>	--	

CALibration[:ALL]?

This command initiates the determination of system error correction data. A "0" is returned if the calibration was successful.

Note: *During the determination of correction data the instrument does not accept any remote control commands, except*
**RST*
CALibration:ABORt

To recognize when the recording of correction data is completed, the MAV bit in the status byte can be used. If the associated bit is set in the Service Request Enable Register, the instrument generates a service request after the recording of correction data has been completed.

Example:

```
"*CLS"
"*SRE 16"
"*CAL?"
```

Resetting the status management.
Enable MAV bit in the Service Request Enable Register.
Starts the correction data recording and then a service request is generated.

Features: *RST value: -
SCPI: conforming

Mode: A

CALibration:ABORt

This command aborts the recording of correction data and restores the last complete correction data set.

Example:

```
"CAL:ABOR"
```

Features: *RST value: -
SCPI: device-specific

Mode: alle

This command is an event and therefore has no *RST value assigned and has no query.

CALibration:RESult?

This command outputs the results of the correction data determination from the instrument. The lines of the table of results (see section "Recording the correction data of FSP – *CAL* key") are output as string data separated by commas:

```
"Total Calibration Status: PASSED","Date (dd/mm/yyyy): 12/07/1999",
"Time: 16:24:54","Runtime:00.06"
```

Example: "CAL:RES?"

Features: *RST value: --
SCPI: device-specific

Mode: alle

CALibration:STATe ON | OFF

This command determines whether (ON) or not (OFF) the current calibration data are taken into consideration.

Example: "CAL:STAT OFF" Switches off the allowance for calibration data.

Features: *RST value: -
SCPI: conforming

Mode: all

DIAGnostic Subsystem

The DIAGnostic subsystem contains the commands which support instrument diagnostics for maintenance, service and repair. In accordance with the SCPI standard, all of these commands are device-specific.

COMMAND	PARAMETERS	UNIT	COMMENT
DIAGnostic			
:SERVice			
:INPut			
[:SELect]	CALibration | RF	--	
:SFUNCtion	<numeric_value>,>numeric_value>	--	no query
:NSOurce	<Boolean>	--	
:CSOurce			
[:POWer]	<numeric_value>	dBm	
:STESt			
:RESult?			

DIAGnostic:SERVice:INPut[:SELect] CALibration | RF

This command toggles between the RF input on the front panel and the internal 128-MHz reference signal. The level of the 128-MHz signals can be selected by command `DIAG:SERV:CSOurce`.

Example: `"DIAG:SERV:INP CAL"`

Features: *RST value: RF
SCPI: device-specific

Mode: all

DIAGnostic:SERVice:SFUNction <string>...

This command activates a service function which can be selected by indicating the five parameters: function group number, board number, function number, parameter 1 and parameter 2 (see service manual). The contents of the parameter string is identical to the code to be entered in the data input field of manual control.

The entry of a service function is accepted only if the system password Level 1 or Level 2 has been entered before (command: `SYSTem:SECurity`).

Note: *The service functions of the FSP family are not identical to those of the FSE family. That is why the IEC/IEEE-bus command differs in the syntax and the data format.*

Example: `"DIAG:SERV:SFUN '2.0.2.12.1'"`

Features: *RST value: -
SCPI: device-specific

Mode: alle

DIAGnostic:SERVice:NSOurce ON | OFF

This command switches the 28-V supply at the rear connector of the noise source on and off.

Example: `"DIAG:SERV:NSO ON"`

Features: *RST value: OFF
SCPI: device-specific

Mode: all

DIAGnostic:SERVice:CSOource[:POWer] <numeric_value>

This command switches the level of the 128 MHz refrence signal source between 0 dBm and -30 dBm.

Example: `"DIAG:SERV:CSO 0DBM"`

Features: *RST value: -30 dBm
SCPI: device-specific

Mode: all

DIAGnostic:SERVice:STESt:RESult?

This command outputs the results of the selftest out of the instrument. The lines of the table of results are output as string data separated by commas:

```
"Total Selftest Status: PASSED","Date (dd/mm/yyyy): 09/07/1999
TIME: 16:24:54","Runtime: 00:06","...
```

Example: `"DIAG:SERV:STES:RES?"`

Features: *RST value: --
SCPI: device-specific

Mode: alle

DISPlay Subsystem

The DISPLay subsystem controls the selection and presentation of textual and graphic information as well as of trace data on the display.
The measurement windows are assigned to WINDow 1 (screen A) or 2 (screen B) .

COMMAND	PARAMETERS	UNIT	COMMENT
DISPlay			
:FORMat	SINGle|SPLit		
:ANNotation			
:FREQuency	<Boolean>		
:LOGO	<Boolean>		
:PSAVe			
[:STATe]	<Boolean>		
:HOLDoff	1 to 60	--	
:CMAP<1 to 26>			
:DEFault<1|2>			
:HSL	0..1,0..1,0..1		
:PDEFined	BLACk | BLUE | BROWn | GREen | CYAN | RED | MAGenta | YELLow | WHITe | DGRAy | LGRAy | LBLUe | LGREen | LCYan | LRED | LMAGenta		
[:WINDow<1|2>]			
:SELect			no query
:TEXT			
[:DATA]	<string>		
:STATe	<Boolean>		
:TIME	<Boolean>		
:TRACe<1 to 3>			
:X			
[:SCALe]			
:Y			
[:SCALe]	<numeric_value>	DB	
:MODE	ABSolute | RELative		
:RLEVel	<numeric_value>	DBM	
:OFFSet	<numeric_value>	DB	
:RPOSition	<numeric_value>	PCT	
:SPACing	LINear|LOGarithmic	--	
:MODE	WRITe|VIEW|AVERage|MAXHold|MINHold	--	
[:STATe]	<Boolean>	--	

DISPlay:FORMat SINGle | SPLit

This command switches the test result display between FULL SCREEN and SPLIT SCREEN. The coupling of settings between screen A and screen B can be selected with the command `INSTrument:COUPle`.

In full-screen display the active measurement window can be selected with `DISPlay:WINDow<1|2>:SELect`.

Example: `"DISP:FORM SPL"` Switches the display to 2 measurement windows.

Features: *RST value: SINGle
SCPI: device-specific

Mode: A

DISPlay:ANNotation:FREQuency ON | OFF

This command switches the X-axis annotation on or off.

Example: `"DISP:ANN:FREQ OFF"`

Features: *RST value: ON
SCPI: conforming

Mode: all

DISPlay:LOGO ON | OFF

This command switches the factory logo on the screen on or off.

Example: `"DISP:LOGO OFF"`

Features: *RST value: ON
SCPI: device-specific

Mode: all

DISPlay:PSAVe[:STATe] ON | OFF

This command switches on or off the power-save mode of the display. With the power-save mode activated the display including backlighting is completely switched off after the elapse of the response time (see command `DISPlay: PSAVe:HOLDoff`).

Note: *This mode is recommended for saving the TFT display especially when the instrument is exclusively operated in the remote control.*

Example: `"DISP:PSAVe ON"` Switches on the power-save mode.

Features: *RST value: OFF
SCPI: device-specific

Mode: all

DISPlay:PSAVe:HOLDoff 1 to 60

This command sets the response time for the power-save mode of the display. The settable value range is 1 to 60 minutes, the resolution 1 minute. The entry is dimensionless.

Example: `"DISP:PSAV:HOLD 30"`

Features: *RST value: 15
SCPI: device-specific

Mode: alle

DISPlay:CMAP<1 to 26>:DEFault<1|2>

This command resets the screen colours of all display items to their default settings. Two default settings DEFault1 and DEFault2 are available. The numeric suffix of CMAP<1 to 13> is irrelevant.

Example: `"DISP:CMAP:DEF2"` Selects default setting 2 for setting the colours.

Features: *RST value: --
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned a query and has no *RST value.

DISPlay:CMAP<1 to 26>:HSL <hue>,<sat>,<lum>

This command defines the colour table of the instrument.

To each numeric suffix of CMAP is assigned one or several picture elements which can be modified by varying the corresponding colour setting. The following assignment applies:

CMAP1 Background
CMAP2 Grid
CMAP3 Function field + status field + data entry text
CMAP4 Function field LED on
CMAP5 Function field LED warn
CMAP6 Enhancement label text
CMAP7 Status field background
CMAP8 Trace 1
CMAP9 Trace 2
CMAP10 Trace 3
CMAP11 Marker
CMAP12 Lines
CMAP13 Measurement status + limit check pass
CMAP14 Limit check fail
CMAP15 Table + softkey background
CMAP16 Table + softkey text
CMAP17 Table selected field text
CMAP18 Table selected field background
CMAP19 Table + data entry field opaq titlebar
CMAP20 Data entry field opaq text
CMAP21 Data entry field opaq background
CMAP22 3D shade bright part
CMAP23 3D shade dark part
CMAP24 Softkey state on
CMAP25 Softkey state data entry
CMAP26 Logo

Parameter: hue = TINT; sat = SATURATION; lum = BRIGHTNESS

The value range is 0 to 1 for all parameters.

Example: `"DISP:CMAP2:HSL 0.3,0.8,1.0"` Changes the grid colour.

Features: *RST value: --
SCPI: conforming

Mode: all

The values set are not changed by *RST.

DISPlay:CMAP<1 to 26>:PDEFined BLACk | BLUE | BROWn | GREen | CYAN | RED | MAGenta | YELLow | WHITe | DGRAy | LGRAy | LBLUe | LGREen | LCYan | LRED | LMAGenta

This command defines the colour table of the instrument using predefined colour values. To each numeric suffix of CMAP is assigned one or several picture elements which can be modified by varying the corresponding colour setting. The same assignment as for `DISPlay:CMAP<1 to 26>:HSL` applies.

Example: `"DISP:CMAP2:PDEF GRE"`

Features: *RST value: --
SCPI: conforming

Mode: all

The values set are not changed by *RST.

DISPlay[:WINDow<1|2>]:SELect

This command selects the active measurement window. WINDow1 corresponds to SCREEN A, WINDow2 to SCREEN B.
In the FULL SCREEN mode, the measurements are only performed in the active measurement window. Measurements are therefore triggered in the active window and result queries (marker, trace data and other results) answered also in the active window.
Triggering measurements and queryíng results in the inactive window yields an error message (execution error).

In the split screen mode, the selection of the active window for result queries is irrelevant.

Note: *In the FULL SCREEN mode, settings can also be performed in the inactive measurement window. They become effective as soon as the corresponding window becomes active.*

Example: `"DISP:WIND2:SEL` Selects SCREEN B as active measurement window.

Features: *RST value: SCREEN A active
SCPI: device-specific

Mode: A

This command is an event and is therefore not assigned a query.

DISPlay[:WINDow<1|2>]:TEXT[:DATA] <string>

This command defines a comment (max. 20 characters) which can be displayed on the screen in the selected measurement window.

Example: `"DISP:WIND2:TEXT 'Noise Measurement'"`
Defines the title for screen B

Features: *RST value: "" (empty)
SCPI: conforming

Mode: all

DISPlay[:WINDow<1|2>]:TEXT:STATe ON | OFF

This command switches on or off the screen display of the comment in the selected measurement window.

Example: "DISP:TEXT:STAT ON" Switches on the title of screen B.

Features: *RST value: OFF
SCPI: conforming

Mode: all

The numeric suffix in WINDow<1|2> is irrelevant.

DISPlay[:WINDow<1|2>]:TIME ON | OFF

This command switches on or off the screen display of date and time. The numeric suffix in WINDow<1|2> is irrelevant.

Example: "DISP:TIME ON"

Features: *RST value: OFF
SCPI: device-specific

Mode: all

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe] 10dB to 200dB

This command defines the display range of the Y-axis (level axis) with logarithmic scaling (DISP:TRAC:Y:SPAC LOG).

For linear scaling, (DISP:TRAC:Y:SPAC LIN | PERC) the display range is fixed and cannot be set. The numeric suffix in TRACe<1 to 3> is irrelevant.

Example: "DISP:TRAC:Y 110dB"

Features: *RST value: 100dB
SCPI: device-specific

Mode: A

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:MODE ABSolute | RELative

This command defines the scale of the Y-axis (absolute or relative) in the selected measurement window.

When SYSTem:DISPlay is set to OFF, this command does not directly influence the screen. The numeric suffix in TRACe<1 to 3> is irrelevant.

Example: "DISP:TRAC:Y:MODE REL"

Features: *RST value: ABS
SCPI: device-specific

Mode: A

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:RLEVel -130dBm to 30dBm

This command defines the reference level in the selected measurement window. Depending on the coupling of the measurement windows, it is valid for the two screens (`INSTrument:COUPle ALL`) or only for the selected measurement window (`INSTrument:COUPle NONE`).

With the reference level offset <> 0 the indicated value range of the reference level is modified by the offset.

The unit depends on the setting performed with `CALCulate:UNIT`. The numeric suffix in TRACe<1 to 3> is irrelevant.

Example: `"DISP:TRAC:Y:RLEV -60dBm"`

Features: *RST value: -20dBm
SCPI: conforming

Mode: A

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:RLEVel:OFFSet -200dB to 200dB

This command defines the offset of the reference level in the selected measurement. Depending on the coupling of the measurement windows, it is valid for the two screens (`INSTrument:COUPle ALL`) or only for the selected measurement window (`INSTrument:COUPle NONE`).

The numeric suffix in TRACe<1 to 3> is irrelevant.

Example: `"DISP:TRAC:Y:RLEV:OFFS -10dB"`

Features: *RST value: 0dB
SCPI: conforming

Mode: A

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:RPOSition 0 to 100PCT

This command defines the position of the reference value in the selected measurement window. The numeric suffix in TRACe<1 to 3> is irrelevant.

Example: `"DISP:TRAC:Y:RPOS 50PCT"`

Features: *RST value: 100PCT
SCPI: conforming

Mode: A

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y:SPACing LINear | LOGarithmic

This command toggles between linear and logarithmic display in the selected measurement window..

The numeric suffix in TRACe<1 to 3> is irrelevant.

Example: `"DISP:TRAC:Y:SPAC LIN"`

Features: *RST value: LOGarithmic
SCPI: conforming

Mode: A

DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:MODE WRITe | VIEW | AVERage | MAXHold | MINHold

This command defines the type of display and the evaluation of the traces in the selected measurement window. WRITE corresponds to the Clr/Write mode of manual operation. The trace is switched off (= BLANK in manual operation) with `DISP:WIND:TRAC:STAT OFF`.

The number of measurements for AVERage, MAXHold and MINHold is defined with the command `SENSe:AVERage:COUNt` or `SENSe:SWEep:COUNt`. It should be noted that synchronization to the end of the indicated number of measurements is only possible in the single-sweep mode.

When the calculation of the average is active, selection can be made between logarithmic and linear average value. For more detail see command `SENSe:AVERage:TYPE`.

Example:

`"SWE:CONT OFF"`	Switching to single-sweep mode.
`"SWE:COUN 16"`	Sets the number of measurements to 16.
`"DISP:WIND1:TRAC3:MODE MAXH"`	Switches on the calculation of the for trace 3 in screen A.
`"INIT;*WAI"`	Starts the measurement and waits for the end of the 16 sweeps.

Features: *RST value: WRITe for TRACe1, STATe OFF for TRACe2 to 4
SCPI: device-specific

Mode: A

DISPlay[:WINDow<1|2>]:TRACE<1 to 3>[:STATe] ON | OFF

This command switches on or off the display of the corresponding trace in the selected measurement window.

Example: `"DISP:TRAC3 ON"`

Features: *RST value: ON for TRACe1, OFF for TRACe2 to 4
SCPI: conforming

FORMat Subsystem

The FORMat subsystem specifies the data format of the data transmitted from and to the instrument.

COMMAND	PARAMETERS	UNIT	COMMENT
FORMat			
[:DATA]	ASCii|REAL[,<numeric_value>]	-	
:DEXPort			
:DSEParator	POINt|COMMa		

FORMat[:DATA] ASCii | REAL [, 32]

This command specifies the data format of the data transmitted from and to the instrument.

Example: `"FORM REAL,32"`
`"FORM ASC"`

Features: *RST value: ASCII
SCPI: conforming

Mode: all

The data format is either ASCII or one of the formats REAL . ASCII data are transmitted in plain text, separated by commas. REAL data are transmitted as 32-bit IEEE 754 floating-point numbers in the "definite length block".

The FORMat command is valid for the transmission of trace data. The data format of trace data received by the instrument is automatically recognized, regardless of the format which is programmed.

Format setting for the binary transmission of trace data (see also `TRACE:DATA?`):

Analyzer mode: REAL, 32

FORMat:DEXPort:DSEParator POINt|COMMA

This command defines which decimal separator (decimal point or comma) is to be used for outputting measurement data to the file in ASCII format. Different languages of evaluation programs (eg MS-Excel) can thus be supported.

Example: `"FORM:DEXP:DSEP POIN` Sets the decimal point as separator.

Features: *RST value: POINt
SCPI: device-specific

Mode: alle

HCOPy Subsystem

The HCOPy subsystem controls the output of display information for documentation purposes on output devices or files. The instrument allows two independent printer configurations which can be set separately with the numeric suffix <1|2>.

COMMAND	PARAMETERS	UNIT	COMMENT
HCOPy			
:ABORt	--	--	no query
:DESTination<1|2>	<string>		no query
:DEVice			
:COLor	<Boolean>		
:LANGuage<1|2>	WMFIGDIIEWMFIBMP		
[:IMMediate<1|2>]	--	--	no query
:ITEM			
:ALL			no query
:WINDow<1|2>			
:TABle			
:STATe	<Boolean>		
:TEXT	<string>		
:TRACe			
:STATe	<Boolean>		
:PAGE			
:ORIentation<1|2>	LANDscapeIPORTrait		

HCOPy:ABORt

This command aborts a running hardcopy output.

Example: `"HCOP:ABOR"`

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

HCOPy:DESTination<1|2> <string>

This command selects the printer output device associated with configuration 1 or 2.

Note: *The type of instrument is selected with* `SYSTem:COMMunicate:PRINter:SELect` *and a preset output medium is set at the same time. The command* `HCOPy:DESTination` *should therefore be sent after setting the device type.*

Parameter: <string>::= `'MMEM' | 'SYST:COMM:PRIN' | 'SYST:COMM:CLIP'`

`'MMEM'`	directs the hardcopy to a file. Command `MMEM:NAME <file_name>` defines the file name. All formats can be selected for `HCOPy:DEVice:LANGuage`.
`'SYST:COMM:PRIN'`	directs the hardcopy to the printer. The printer is selected with command `SYSTEM:COMMunicate:PRINter:SELect`. `GDI` should be selected for `HCOPy:DEVice:LANGuage`.
`'SYST:COMM:CLIP'`	directs the hardcopy to the clipboard. `EWMF` should be selected for `HCOPy:DEVice:LANGuage`.

Example:

`"SYST:COMM:PRIN:SEL2 'LASER on LPT1'"`	Selects the printer and output medium for device 2
`"HCOP:DEST2 'SYST:COMM:PRIN'"`	Selects the printer interface as device 2.

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

HCOPy:DEVice:COLor ON|OFF

This command selects between colour and monochrome hardcopy of the screen.

Example: `"HCOP:DEV:COL ON"`

Features: *RST value: OFF
SCPI: conforming

Mode: all

HCOPy:DEVice:LANGuage<1|2> GDI | WMF | EWMF | BMP

This command determines the data format of the printout.

Parameter:

GDI (Graphics Device Interface)
Default format for the output to a printer configured under Windows. Should be selected for the output to the printer interface (`HCOPy:DEVice 'SYST:COMM:PRIN'`).
Can be used for the output to a file (`HCOPy:DEVice 'SYST:COMM:MMEM'`). The printer driver configured under Windows is then used and a printer-specific file format is thus generated.

WMF and EWMF (WINDOWS Metafile and Enhanced Metafile Format)
Data formats for output files which can at a later time be integrated in corresponding programs for documentation purposes. WMF can only be used for the output to a file (`HCOPy:DEVice 'SYST:COMM:MMEM'`) and EWMF also for the output to the clipboard (`HCOPy:DEVice 'SYST:COMM:CLIP'`).

BMP (Bitmap) Data format for output files.

Example: `"HCOP:DEV:LANG WMF"`

Features: *RST value: -
SCPI: conforming

Mode: all

HCOPy[:IMMediate<1|2>]

This command starts a hardcopy output. The numeric suffix selects which printer configuration (1 or 2) is to be used for the hardcopy output. If there is no suffix, configuration 1 is automatically selected.

`HCOPy:IMM[1]` Starts the hardcopy output to device 1 (default).
`HCOPy:IMM2` Starts the output to device 2.

Example: `"HCOP"`

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

HCOPy:ITEM:ALL

This command selects the complete screen to be output.

Example: `"HCOP:ITEM:ALL"`

Features: *RST value: OFF
SCPI: conforming

Mode: all

The hardcopy output is always provided with comments, title, time and date. As an alternative to the whole screen, only traces (commands `'HCOPy:DEVice:WINDow:TRACe: STATe ON'`) or tables (command `'HCOPy:DEVice:WINDow:TABLe:STATe ON'`) can be output.

HCOPy:ITEM:WINDow<1|2>:TABle:STATe ON | OFF

This command selects the output of the currently displayed tables (ON).

Example: `"HCOP:ITEM:WIND:TABL:STAT ON"`

Features: *RST value: OFF
SCPI: device-specific

Mode: all

The command `HCOPy:DEVice:ITEM:WINDow<1|2>:TABle:STATe OFF` same as command `HCOPy:DEVice:ITEM:ALL` enables the output of the whole screen.

HCOPy:ITEM:WINDow<1|2>:TEXT <string>

This command defines the comment text for printout to measurement window 1 or 2 with a maximum of 100 characters; line feed by means of character @).

Example: `"HCOP:ITEM:WIND2:TEXT 'comment'"`

Features: *RST value: -
SCPI: device-specific

Mode: all

HCOPy:ITEM:WINDow<1|2>:TRACe:STATe ON | OFF

This command selects the output of the currently displayed trace (ON).

Example: `"HCOP:ITEM:WIND:TRACe:STAT ON"`

Features: *RST value: OFF
SCPI: device-specific

Mode: all

The command `HCOPy:ITEM:WINDow<1|2>:TRACe:STATe OFF` same as command `HCOPy:ITEM:ALL` enables the output of the whole screen.

HCOPy:PAGE:ORIentation<1|2> LANDscape | PORTrait

The command selects the format of the output (portrait and landscape) (hardcopy unit 1 or 2).

Example: `"HCOP:PAGE:ORI LAND"`

Features: *RST value: -
SCPI: conforming

Mode: all

INITiate Subsystem

The INITiate subsystem checks the initialization of the trigger subsystem in the selected measurement window. The measurement windows are assigned to INITiate1 (screen A) and INITiate2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
INITiate<1|2>			
:CONTinuous	<boolean>	--	
:CONMeas	--	--	no query
[:IMMediate]	--	--	no query
:DISPlay	<boolean>	--	

INITiate<1|2>:CONTinuous ON | OFF

This command determines if the trigger system is continuously initiated (continuous) or performs single measurements (single). In the signal analysis mode, this setting refers to the sweep sequence (switching between continuous/single sweep).).

On switching to single sweep, the sequence is immediately stopped.

Example: `"INIT2:CONT OFF"` Switches the sequence in screen B to single sweep.

`"INIT2:CONT ON"` Switches the sequence to continuous sweep.

Features: *RST value: ON
SCPI: conforming

Mode: all

INITiate<1|2>:CONMeas

This command continues a stopped measurement at the current position in the single-sweep mode. The function is useful especially for trace functions MAXHold, MINHold and AVERage if the previous results are not to be cleared with Sweep Count > 0 or Average Count > 0 on restarting the measurement (INIT:IMMediate resets the previous results on restarting the measurement).

The single-sweep mode is automatically switched on. Synchronization can then be performed to the end of the indicated number of measurements with the command *OPC, *OPC? or *WAI. In the continuous-sweep mode, synchronization to the sweep end is not possible since the total measurement never ends.

Example:

```
"INIT:CONT OFF"          Switchover to single-sweep mode.
"DISP:WIND:TRAC:MODE AVER" Switching on trace averaging.
"SWE:COUN 20"            Setting the sweep counter to 20 sweeps.
"INIT;*WAI"              Starts the measurement and waits for the
                         end of the 20 sweeps.
"INIT:CONM;*WAI"         Continues the measurement (next 20
                         sequences) and waits for the end.
```

Features: *RST value: -
SCPI: device-specific

Mode: all

This command is an event and therefore has no *RST value and has no query.

INITiate<1|2>[:IMMediate]

The command initiates a new sweep. With Sweep Count > 0 or Average Count > 0, this means a restart of the indicated number of measurements. With trace functions MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

In the single-sweep mode, synchronization can be made to the end of the indicated number of measurements with the command *OPC, *OPC? or *WAI. In the continuous-sweep mode, synchronization to the sweep end is not possible since the total measurement never ends.

Example:

```
"INIT:CONT OFF"              Switchover to single-sweep mode.
"DISP:WIND:TRAC:MODE AVER    Switching on trace averaging.
"SWE:COUN 20"                Setting the sweep counter to 20 sweeps.
"INIT;*WAI"                  Starts the measurement and waits for the
                             end of the 20 sweeps.
```

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

INITiate<1|2>:DISPlay ON | OFF

This command switches the display on or off during a single sweep. The numeric suffix of INITiate is irrelevant with this command.

Example:

```
"INIT:DISP OFF"
```

Features: *RST value: ON
SCPI: device-specific

Mode: A

INPut Subsystem

The INPut subsystem checks the input features of the instrument. The measurement windows are assigned to INPut1 (screen A) and INPut2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
INPut<1|2>			
:ATTenuation	<numeric_value>	DB	
:AUTO	<Boolean>	--	
:IMPedance	50 | 75	OHM	

INPut<1|2>:ATTenuation 0 to 70 dB

This command programs the input attenuator. To protect the input mixer against damage from overloads, the setting 0 dB can be obtained by entering numerals, not by using the command DEC.

The step width is 10 dB without the option electronic attenuator.
The input attenuation can be set in 5 dB steps with the option electronic attenuator.

In the default state, the attenuation set on the step attenuator is coupled to the reference level of the instrument. If the attenuation is programmed directly, the coupling to the reference level is switched off.

Example: `"INP:ATT 40dB"` Sets the attenuation set on the attenuator to 40 dB and switches off the coupling to the reference level.

Features: *RST value: - (AUTO is set to ON)
SCPI: conforming

Mode: all

INPut<1|2>:ATTenuation:AUTO ON | OFF

This command automatically couples the input attenuation to the reference level (state ON) or switches the input attenuation to manual entry (state OFF). The minimum input attenuation set with the coupling switched on is - 10 dB (with electronic attenuator option: -5 dB).

Example: `"INP:ATT:AUTO ON"` Couples the attenuation set on the attenuator to the reference level.

Features: *RST value: ON
SCPI: conforming

Mode: all

INPut<1|2>:IMPedance 50 | 75

This command sets the nominal input impedance of the instrument. The set impedance is taken into account in all level indications of results..

Example: `"INP:IMP 75"`

Features: *RST value: 50
SCPI: conforming

Mode: all

INSTrument Subsystem

COMMAND	PARAMETERS	UNIT	COMMENT
INSTrument<1|2>			
[:SELect]	SANalyzer		
:NSELect	<numeric_value>		no query
:COUPle	NONE | RLEVel | CF_B | CF_A		

INSTrument<1|2>[:SELect] SANalyzer

This command switches between the operating modes by means of text parameters.The numeric suffix <1|2> selects between screen A and screen B.

Parameter: SANalyzer: Spectrum analysis

Example: `"INST SAN"` Switches screen A to spectrum analyzer mode.

Features: *RST value: SANalyzer
SCPI: conforming

Mode: all

INSTrument<1|2>:NSELect 1

This command switches between the operating modes by means of numbers.

Example: `"INST:NSEL 1"` Swtiches screen A to spectrum analyzer mode.

Features: *RST value: 1
SCPI: conforming

Mode: all

INSTrument:COUPle NONE | RLEVel | CF_B | CF_A

This command defines the coupling between the two measurement windows screen A and B.

Parameter:

NONE — No coupling. The two measurement windos are operated like two independent "virtual" devices.

RLEVel — The reference levels of the two measurement windows are coupled.

CF_B — The center frequency of screen B is coupled to the frequency of marker 1 in screen A.

CF_A — The center frequency of screen A is coupled to the frequency of marker 1 in screen B.

Example: `"INST:COUP NONE"` Switches off the coupling of measurement windows. Two independent "virtual" devices are then obtained.

Features: *RST value: NONE
SCPI: device specific

Mode: A

MMEMory Subsystem

The MMEMory (mass memory) subsystem provides commands which allow for access to the storage media of the instrument and for storing and loading various instrument settings.
The NAME command stores the HCOPy outputs in a file.

The various drives can be addressed via the mass storage unit specifier <msus> using the conventional DOS syntax. The internal hard disk is addressed by "D:", the floppy-disk drive installed by "A:".
The file names <file_name> are indicated as string parameters with the commands being enclosed in quotation marks. They comply with conventions.

Note: *For reasons of compatibility with the FSE instruments, addressing the hard disk by "C:" is also accepted. Since hard disk "C:" is reserved for instrument software in the FSP, all read and write operations are rerouted to hard disk "D:" in normal operation (no service level)*

DOS file names consist of max. 8 ASCII characters and an extension of up to three characters separated from the file name by a colon "." Both, the colon and the extension are optional. The colon is not part of the file name. DOS file names do not differ between uppercase and lowercase notation. All letters and digits are permitted as well as the special characters "_", "^", "$", "~", "!", "#", "%", "&", "-", "{", "}", "(", ")", "@" and "‘". Reserved file names are CLOCK$, CON, AUX, COM1 to COM4, LPT1 to LPT3, NUL and PRN.

The two characters "*" and "?" have the function of so-called "wildcards", i.e., they are variables for selection of several files. The question mark "?" replaces exactly one character which may be any, the asterisk means any of the remaining characters in the file name. "*.*" thus means all files in a directory.

COMMAND	PARAMETERS	UNIT	COMMENT
MMEMory			
:CDIRectory	<directory_name>	--	
:COPY	<file_name>,<file_name>	--	no query
:DATA	<file name>[,<block>]	--	
:DELete	<file_name>	--	no query
:INITialize	<msus>	--	no query
:LOAD			
:STATe	1,<file_name>	--	no query
:AUTO	1,<file_name>	--	no query
:MDIRectory	<directory_name>	--	no query
:MOVE	<file_name>,<file_name>	--	no query
:MSIS	<msus>	--	
:NAME	<file_name>	--	
:RDIRectory	<directory_name>	--	no query
:STORe<1|2>			
:STATe	1,<file_name>	--	no query
:TRACe	<numeric_value>, <file_name>		
:CLEar		--	
:STATe	1,<file_name>		no query
:ALL			no query

COMMAND	PARAMETERS	UNIT	COMMENT
:SELect			
[:ITEM]			
:HWSettings	<Boolean>		
:TRACE	<Boolean>		
:LINes			
:ALL	<Boolean>		
:ALL	--		no query
:NONE	--		no query
:DEFault	--		no query
:COMMent	<string>		

MMEMory:CDIRectory <directory_name>

This command changes the current directory..

In addition to the path name, the indication of the directory may contain the drive name. The path name complies with the DOS conventions.

Parameter: <directory_name>::= DOS path name

Example: "MMEM:CDIR 'D:\USER\DATA'"

Features: *RST value: -
SCPI: conforming

Mode: all

MMEMory:COPY <file_source>,<file_destination>

This command copies the files indicated in <file_source> to the destination directory indicated with <file_destination> or to the destination file designated by <file_destination> when <file_source> is just a file.

The indication of the file name may include the path and the drive. The file names and path information must be in accordance with the DOS conventions.

Parameter: <file_source>,<file_destination> ::= <file_name>
<file_name> ::= DOS file name

Example: "MMEM:COPY 'D:\USER\DATA\SETUP.CFG','A:'"

Features: *RST value: -
SCPI conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:DATA <file_name>[,<block data>]

This command writes block data to the specified file.

This command writes the block data contained in <block> in the file characterized by <file_name>. The IEC/IEEE-bus delimiter should be set to EOI to obtain error-free data transfer.

The associated query reads the indicated file from the mass memory and transfers it to the controller via the IEC/IEEE bus. It should be noted that the buffer memory of the controller should be large enough to store the file. The setting of the IEC/IEEE-bus delimiter is irrelevant in this case.

The command is useful for reading stored device settings or trace data from the instrument or for transferring them to the instrument.

Syntax:

MMEMory:DATA <file_name>,<block data>	Data transfer from controller to instrument.
MMEMory:DATA? <file_name>	Data transfer from instrument to controller.

<file_name> designates the file to be transferred.

The binary data block <block> has the following structure:

- it always begins with the character '#',
- followed by a digit for the length of the length information,
- then the indicated number of digits as length information (number of bytes) for the binary data themselves,
- finally the binary data in the indicated number of bytes

Example:

`"MMEM:DATA 'TEST01.HCP', #217This is the file"`
means:
#2: the next 2 characters are the length indication
17: number of subsequent binary data bytes
This is the file:
17 bytes stored as binary data in the file TEST01.HCP.

`"MMEM:DATA? 'TEST01.HCP'"` Transfers the file TEST01.HCP from the instrument to the controller.

Features:

*RST value: -
SCPI: conforming

Mode: all

MMEMory:DELete <file_name>

This command deletes the files indicated.

The indication of the file name contains the path and, optionally, the drive. Indication of the path complies with conventions.

Parameter: <file_name> ::= DOS file name

Example: `"MMEM:DEL 'TEST01.HCP'"` The file TEST01.HCP is deleted.

Features:

*RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:INITialize 'A:'

This command formats the disk in drive A. Formatting deletes all data stored on the floppy disk.

Parameter: <msus> ::= 'A:'
No drive names can be given except drive A:.

Example: "MMEM:INIT 'A:'"

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:LOAD:STATe 1,<file_name>

This command loads device settings from files.The contents of the file is loaded and set as new device state. The device automatically recognizes the files that are required for the whole setup from the list of file extensions:

Contents	Extension
Current setting of measurement hardware and associated title, if indicated	.SET
Activated limit lines	.LIN
Current configuration of general device parameters	.CFG
Configuration for the hardcopy output	.HCS
User-defined colour setting	.COL
All defined limit lines	.LIA
Measured data trace 1 to trace 3 screen A	.TR1 to 3
Measured data trace 1 to trace 3 screen B	.TR4 to 6

The file name includes indication of the path and may also include the drive. The path name complies with conventions.

Parameter: <file_name> ::= DOS file name without extension, extensions see table

Example: "MMEM:LOAD:STAT 1,'A:TEST'"

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:LOAD:AUTO 1,<file_name>

This command defines which device setting is automatically loaded after the device is switched on. The contents of the file are read after switching on the device and used to define the new device state. The file name includes indication of the path and may also include the drive. The path name complies with conventions.

Parameter: <file_name> ::= DOS file name without extension;
FACTORY denotes the data set previously in the instrument

Example: "MMEM:LOAD:AUTO 1,'D:\USER\DATA\TEST'"

Features: *RST value: FACTORY
SCPI: device-specific

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:MDIRectory <directory_name>

This command creates a new directory. The file name includes indication of the path and may also include the drive. The path name complies with conventions.

Parameter: <directory_name>::= DOS path name

Example: "MMEM:MDIR 'D:\USER\DATA'"

Features: *RST value: -
SCPI: device-specific

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:MOVE <file_source>,<file_destination>

This command renames existing files, if <file_destination> contains no path indication. Otherwise the file is moved to the indicated path and stored under the file name specified there, if any.

The file name includes indication of the path and may also include the drive. The path name complies with conventions.

Parameter: <file_source>,<file_destination> ::= <file_name>
<file_name> ::= DOS file name

Example: "MMEM:MOVE 'D:\TEST01.CFG','SETUP.CFG'"
Renames TEST01.CFG in SETUP.CFG in directory D:\.

"MMEM:MOVE 'D:\TEST01.CFG','D:\USER\DATA'"
Moves TEST01.CFG from D:\ to D:\USER\DATA.

"MMEM:MOVE 'D:\TEST01.CFG','D:\USER\DATA\SETUP.CFG'"
Moves TEST01.CFG from D:\ to D:\USER\DATA and renames the file in SETUP.CFG.

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:MSIS 'A:' | 'D:'

This command changes to the drive indicated.The drive may be the internal hard disk D: or the floppy-disk drive A:. The drive is indicated according to the DOS conventions.

Example: "MMEM:MSIS 'A:'"

Features: *RST value: "D:'
SCPI: conforming

Mode: all

MMEMory:NAME <file_name>

This command defines a file in which a printout is done with the command HCOPy:IMMediate. The output to the printer is routed into a file using the command "HCOP:DEST 'MMEM'".

The file name includes indication of the path and may also include the drive. The file name and path information comply with conventions.

Parameter: <file_name> ::= DOS filename

Example: HCOP:DEV:LANG BMP" Selection of data format.
"MMEM:NAME 'PRINT1.BMP'" Selection of file name.

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:RDIRectory <directory_name>

This command deletes the directory indicated. The directory name includes indication of the path and may also include the drive. The path name complies with conventions.

Parameter: <directory_name>::= DOS path name

Example: "MMEM:RDIR 'D:\TEST'"

Features: *RST value: -
SCPI: device-specific

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:STORe<1|2>:STATe 1,<file_name>

This command stores the current device setting in a series of files which have the indicated file name but different extensions. The file name includes indication of the path and may also include the drive. The path name complies with DOS conventions. The numeric suffix in STORe<1|2> is irrelevant with this command.

A list of the extensions used is contained under `MMEMory:LOAD:STATe`.

Parameter: <file_name> ::= DOS file name without extension

Example: `"MMEM:STOR:STAT 1,'TEST'"`

Features: *RST value: -
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:STORe<1|2>:TRACe 1 to 3,<file_name>

This command stores the trace selected with 1 to 3 in the measurement window indicated with STORe<1|2> (screen A or B) in a file with ASCII format. The file format is described in chapter 4 in the TRACE menu under the *ASCII-FILE EXPORT* softkey.

The decimal separator (decimal point or comma) for floating-point numerals contained in the file is defined with the command `FORMat:DEXPort:DSEParator`.

The file name includes indication of the path and the drive name. Indication of the path complies with DOS conventions.

Parameter: 1 to 3 := selected measurement curve Trace 1 to 3
<file_name> := DOS file name

Example:
```
"MMEM:STOR2:TRAC 3,'A:\TEST.ASC'"
                                    Stores trace 3 from screen B in
                                    the file TEST.ASC on a disk.
```

Features: *RST value: -
SCPI: device-specific

Mode: alle

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:CLEar:STATe 1,<file_name>

This command deletes the instrument setting denoted by <file_name>. All associated files on the mass memory are cleared. A list of the extensions used is contained under `MMEMory:LOAD:STATe`.

The file name includes indication of the path and may also include the drive. The path name complies with conventions.

Parameter: <file_name> ::= DOS file name without extension

Example: `"MMEM:CLE:STAT 1,'TEST'"`

Features: *RST value: -
SCPI: device-specific

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:CLEar:ALL

This command deletes all device settings in the current directory.The current directory can be selected with `MMEM:CDIR`. The default directory is D:.

Example: `"MMEM:CLE:ALL"`

Features: *RST value: -
SCPI: device-specific

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

MMEMory:SELect[:ITEM]:HWSettings ON | OFF

This command includes the hardware settings in the list of data subsets of a device setting to be stored/loaded. The hardware settings of FSP include:

- current configuration of general device parameters (general setup)
- current setting of the measurement hardware including markers
- activated limit lines:
  A data set may include 8 limit lines at maximum in each measurement window. It comprises the activated limit lines and, if available, the de-activated limit lines last used.
  Therefore the combination of the non-activated restored limit lines depends on the sequence of use with the command `MMEM:LOAD`.
- user-defined colour setting
- configuration for the hardcopy output

Example: `"MMEM:SEL:HWS ON"`

Features: *RST value: ON
SCPI: device-specific

Mode: all

MMEMory:SELect[:ITEM]:TRACE ON | OFF

This command includes the data of the active traces in the list of data subsets of a device setting to be stored/loaded. All traces whose state is not blank are active.

Example: `"MMEM:SEL:TRAC ON"`

Features: *RST value: OFF for all traces
SCPI: device-specific

Mode: all

MMEMory:SELect[:ITEM]:LINes:ALL ON | OFF

This command includes all limit lines (activated and de-activated) in the list of data subsets of a device setting to be stored/loaded.The selection `MMEM:SEL:LIN:ACT` is thus switched off.

Example: `"MMEM:SEL:LIN:ALL ON"`

Features: *RST value: ON
SCPI: device-specific

Mode: all

MMEMory:SELect[:ITEM]:ALL

This command includes all data subsets in the list of data subsets of a device setting to be stored/loaded.

Example: "MMEM:SEL:ALL"

Features: *RST value: --
SCPI: device-specific

Mode: all

This command is an event and therefore has no *RST value assigned.

MMEMory:SELect[:ITEM]:NONE

This command deletes all data subsets in the list of data subsets of a device setting to be stored/loaded.

Example: "MMEM:SEL:NONE"

Features: *RST value: --
SCPI: device-specific

Mode: all

This command is an event and therefore has no *RST value assigned.

MMEMory:SELect[:ITEM]:DEFault

This command sets the default list of the data subsets of a device setting to be stored/loaded.The latter includes:

- current configuration of general device parameters (general setup)
- current setting of the measurement hardware including markers
- activated limit lines
- user-defined colour setting
- configuration for the hardcopy output

Trace data and non-used limit lines are not included.

Example: "MMEM:SEL:DEFault"

Features: *RST value: --
SCPI: device-specific

Mode: all

This command is an event and therefore has no *RST value assigned.

MMEMory:COMMent <string>

This command defines a comment (max. 60 characters) for a device setting to be stored.

Example: "MMEM:COMM 'Setup for GSM measurement'"

Features: *RST value: blank comment
SCPI: device-specific

Mode: all

SENSe Subsystem

The SENSe subsystem is itself divided up into several subsystems. The commands of these subsystems directly control device-specific settings, they do not refer to the signal characteristics of the measurement signal.
The SENSe subsystem controls the essential parameters of the analyzer. In accordance with the SCPI standard, it is for this reason optional, which means that it is not necessary to include the SENSe node in command sequences.
The measurement windows are assigned to SENSe1 and SENSe2:

SENSe1 = Modification of screen A settings
SENSe2 = Modification of screen B settings.

Screen A is automatically selected if 1 or 2 is missing.

SENSe:AVERage Subsystem

The SENSe:AVERage subsystem calculates the average of the data acquired. A new test result is obtained from various successive measurements. The amount of test points and the axis reference of the new result correspond to those of the original measurements. There are two types of average calculation: logarithmic and linear. In case of logarithmic average calculation (denoted with VIDeo), the average value of the measured level is calculated and in case of linear average calculation, the power is averaged before the level is determined by logarithmic calculation.
The measurement windows are assigned to SENSe1 (screen A) and SENSe2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
[SENSe<1|2>]			
:AVERage			
:COUNt	<numeric_value>	--	
[:STATe<1 to 3>]	<Boolean>	--	
:TYPE	VIDeo | LINear	--	

[SENSe<1|2>:]AVERage:COUNt 0 to 32767

This command defines the number of measurements over which the average value is determined.

It should be noted that continuous averaging will take place after the indicated number has been reached in the continuous sweep mode.

In the single-sweep mode, the indicated number of measurements (sweeps) is reached and the sweep is then stopped. Synchronization to the end of the indicated number of measurements is only possible in the single-sweep mode.

The command `[SENSe<1|2>:]AVERage:COUNt` is the same as command `[SENSe<1|2>:]SWEep:COUNt`. In both cases, the number of measurements is defined whether the average calculation is active or not.

The number of measurements is valid for all traces in the indicated measurement window.

Example:

```
"SWE:CONT OFF"    Switching to single-sweep mode.
"AVER:COUN 16"    Sets the number of measurements to 16.
"AVER:STAT ON"    Switches on the calculation of average.
"INIT;*WAI"       Starts the measurement and waits for the end of the 16
                  sweeps.
```

Features: *RST value: 0
SCPI: conforming

Mode: all

[SENSe<1|2>:]AVERage[:STATe<1 to 3>] ON | OFF

This command switches on or off the calculation of average for the selected trace (STATe<1 to 3>) in the selected measurement window.

Example: `"AVER OFF"` Switches off the calculation of average for trace 1 in screen A.

`"SENS2:AVER:STAT3 ON"` Switches on the calculation of average for trace 3 in screen B.

Features: *RST value: OFF
SCPI: conforming

Mode: all

[SENSe<1|2>:]AVERage:TYPE VIDeo | LINear

The command selects the type of average function.If VIDeo is selected, the logaritmized levels are averaged and, if LINear is selected, the power values are averaged before they are converted to levels.

The type of average calculation is equally set for all traces in one measurement window.

Example: `"AVER:TYPE LIN"` Switches screen A to linear average calculation.

Features: *RST value: SCALar
SCPI: conforming

Mode: all

SENSe:BANDwidth Subsystem

This subsystem controls the setting of the instrument's filter bandwidths. Both groups of commands (BANDwidth and BWIDth) perform the same functions.
The measurement windows are assigned to SENSe1 (screen A) and SENSe2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
[SENSe<1|2>]			
:BANDwidth | :BWIDth			
[:RESolution]	<numeric_value>	HZ	
:AUTO	<Boolean>	--	
:MODE	ANALog|DIGital	--	
:FFT	<Boolean>	--	
:RATio	<numeric_value>	--	
:VIDeo	<numeric_value>	HZ	
:AUTO	<Boolean>	--	
:RATio	<numeric_value>	--	

[SENSe<1|2>:]BANDwidth|BWIDth[:RESolution] <numeric_value>

This command defines the analyzer's resolution bandwidth. Analog resolution filters of 10 Hz to 10 MHz in 1, 3, 10 steps are available. These filters are implemented as 4-circuit LC filters in the range of 100 kHz to 10 MHz and as digital filters with analog characteristic in the range of 10 Hz to 30 kHz.

In addition, the EMI bandwidths 200 Hz, 9 kHz and 120 kHz are available (6 dB bandwidths each). These bandwidths can only be obtained by entering numeric values and not with the commands `INCrement` and `DECrement`.

FFT filters of 1 Hz to 30 kHz in 1, 3, 10 steps (3 dB bandwidth each) are also available for fast measurements on periodic signals. The instrument automatically switches to analog filters above 30 kHz.

If the resolution bandwidth is modified, the coupling to the span is automatically switched off.

Example: `"BAND 1MHz"`

Features: *RST value: - (AUTO is set to ON)
SCPI: conforming

Mode: all

[SENSe<1|2>:]BANDwidth|BWIDth[:RESolution]:AUTO ON | OFF

This command either automatically couples the resolution bandwidth of the instrument to the span or cancels the coupling.

The automatic coupling matches the resolution bandwidth to the currently set frequency span according to the relationship between frequency span and resolution bandwidth. The 6 dB bandwidths 200 Hz, 9 kHz and 120 kHz are not set by the automatic coupling.

The ratio resolution bandwidth/span can be modified with the command `[SENSe<1|2>:]BANDwidth[:RESolution]:RATio`.

Example: `"BAND:AUTO OFF"` Switches on the coupling of the resolution bandwidth to the span.

Features: *RST value: ON
SCPI: conforming

Mode: A

The automatic coupling matches the resolution bandwidth to the currently set span according to the relationship between span and resolution bandwidth.

[SENSe<1|2>:]BANDwidth|BWIDth[:RESolution]:MODE:FFT ON | OFF

This command switches the digital filters used for the bandwidths ≤ 30 kHz between normal mode and FFT filtering. The analog LC filters continue to be used for bandwidths > 30 kHz.

FFT filtering offers a higher measurement speed as compared to the digital filters with analog characteristic. However, FFT filters are only suitable for periodic signals.

Example: `"BAND:MODE:FFT ON"`

Features: *RST value: OFF
SCPI: device-specific

Mode: A

[SENSe<1|2>:]BANDwidth|BWIDth[:RESolution]:RATio 0.0001 to 1

This command defines the ratio resolution bandwidth (Hz) / span (Hz). The ratio to be entered is reciprocal to the ratio span/RBW used in manual control.

Example: `"BAND:RAT 0.1"`

Features: *RST value: 0.02 with BAND:MODE:FFT OFF or RBW > 30 kHz
0.01 with BAND:MODE:FFT ON for RBW ≤ 30 kHz
SCPI: conforming

Mode: A

[SENSe<1|2>:]BANDwidth|BWIDth:VIDeo 1Hz to 10MHz

This command defines the instrument's video bandwidth.Bandwidths from 10 Hz to 10 MHz in 1, 3, 10 steps are available. The command is not available if FFT filtering is switched on and the set bandwidth is ≤ 30 kHz or if the quasi-peak detector is switched on.

Example: `"BAND:VID 10kHz"`

Features: *RST value: - (AUTO is set to ON)
SCPI: conforming

Mode: A

[SENSe<1|2>:]BANDwidth|BWIDth:VIDeo:AUTO ON | OFF

This command either automatically couples the instrument's video bandwidth to the resolution bandwidth or cancels the coupling.

The ratio resolution bandwidth/span can be modified with the command `[SENSe<1|2>:]BANDwidth[:RESolution]:RATio`.

Example: `"BAND:VID:AUTO OFF"`

Features: *RST value: ON
SCPI: conforming

Mode: A

[SENSe<1|2>:]BANDwidth|BWIDth:VIDeo:RATio 0.01 to 1000

This command defines the ratio video bandwidth (Hz) / resolution bandwidth (Hz).The ratio to be entered is reciprocal to the ratio RBW/VBW used in manual control.

Example: `"BAND:VID:RAT 3"` Sets the coupling of video bandwidth to video bandwidth = 3*resolution bandwidth

Features: *RST value: 3
SCPI: conforming

Mode: A

The ratio to be entered is reciprocal to the ratio RBW/VBW used in manual control.

SENSe:DETector Subsystem

The SENSe:DETector subsystem controls the recording of measurement values via the type of detector selected for each trace. The measurement windows are assigned to SENSe1 (screen A) and SENSe2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
[SENSe<1|2>] :DETector<1 to 3> [:FUNCtion]	APEak | NEGative| POSitive | SAMPle| RMS | AVERage | QPEak		
:AUTO	<Boolean>		

[SENSe<1|2>:]DETector<1..3>[:FUNCtion] APEak | NEGative | POSitive | SAMPle | RMS | AVERage | QPEak

This command switches on the detector for the recording of measured values on the selected trace in the indicated measurement window.

- The APEak detector (AutoPeak) displays the positive and also the negative peak value in the presence of noise. If a signal is detected, only the positive peak value is displayed.
- The POSitive or NEGative detector only displays the positive or the negative peak value.
- With the Sample detector the value indicated at the time of recording is displayed whereas the rms value of the power measured at each test point is displayed with the RMS detector.
- The AVERage detector displays the power average value at each test point.
- The QPEak detector performs a signal evaluation for the EMC measurement technology.

If QPEak is selected, the video filter is automatically switched off. The couplings between span and RBW as well as between RBW and sweep time are also switched off and restored on selecting another detector. A long sweep time should be selected so that the quasi-peak detector can fully settle at each test point.

The trace is indicated as numeric suffix in `DETector`.

Example: `"DET POS"` Sets the detector in screen A to "positive peak".

Features: *RST value: APEak
SCPI: conforming

Mode: A

[SENSe<1|2>:]DETector<1 to 3>[:FUNCtion]:AUTO ON | OFF

This command either couples the detector in the selected measurement window to the current trace setting or turns coupling off.

Example: `"DET:AUTO OFF"`

Features: *RST value: ON
SCPI: conforming

Mode: A

The trace is defined by the numeric suffix at DETector.

SENSe:FREQuency Subsystem

The SENSe:FREQuency subsystem defines the frequencY-axis of the active display. The frequencY-axis can either be defined via the start/stop frequency or via the center frequency and span. The measurement windows are assigned to SENSe1 (screen A) and SENSe2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
[SENSe<1|2>]			
:FREQuency			
:CENTer	<numeric_value>	HZ	
:STEP	<numeric_value>	HZ	
:LINK	SPAN|RBW|OFF	--	
:FACTor	<numeric_value>	PCT	
:SPAN	<numeric_value>	HZ	
:FULL	--	--	
:STARt	<numeric_value>	HZ	
:STOP	<numeric_value>	HZ	
:MODE	CW|FIXed|SWEep		
:OFFSet	<numeric_value>	HZ	

[SENSe<1|2>:]FREQuency:CENTer 0 GHz to f_{max}

This command defines the center frequency of the analyzer or the measuring frequency for span = 0.

Example: `"FREQ:CENT 100MHz"`

Features: *RST value: f_{max} /2 with f_{max} = upper limit frequency of the analyzer
SCPI: conforming

Mode: all

In the analyzer mode, the automatic coupling of the parameters is set to SPAN FIXED.

[SENSe<1|2>:]FREQuency:CENTer:STEP 0 to f_{max}

This command defines the step width of the center frequency.

Example: `"FREQ:CENT:STEP 120MHz"`

Features: *RST value: - (AUTO 0.1 × SPAN is switched on)
SCPI: conforming

Mode: all

[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK SPAN | RBW | OFF

This command couples the step width of the center frequency to span (span >0) or to the resolution bandwidth (span = 0) or cancels the couplings.

Example: `"FREQ:CENT:STEP:LINK SPAN"`

Features: *RST value: SPAN
SCPI: device-specific

Mode: A

[SENSe<1|2>:]FREQuency:CENTer:STEP:LINK:FACTor 1 to 100 PCT

This command couples the step width of the center frequency with a factor to the span (span >0) or to the resolution bandwidth (span = 0).

Example: `"FREQ:CENT:STEP:LINK:FACT 20PCT"`

Features: *RST value: - (AUTO 0.1 × SPAN is switched on)
SCPI: device-specific

Mode: A

[SENSe<1|2>:]FREQuency:SPAN 0 GHz to f_{max}

This command defines the frequency span of the analyzer.

Example: `"FREQ:SPAN 10MHz"`

Features: *RST value: f_{max} with f_{max} = upper limit frequency of the analyzer
SCPI: conforming

Mode: A

[SENSe<1|2>:]FREQuency:SPAN:FULL

This command sets the maximum frequency span of the analyzer.

Example: `"FREQ:SPAN:FULL"`

Features: *RST value: -
SCPI: conforming

Mode: A

[SENSe<1|2>:]FREQuency:STARt 0 GHz to f_{max}

This command defines the start frequency of the analyzer. This command is only available in the frequency domain (span >0).

Example: `"FREQ:STAR 20MHz"`

Features: *RST value: 0
SCPI: conforming

Mode: E, A

[SENSe<1|2>:]FREQuency:STOP 0 GHz to f_{max}

This command defines the stop frequency of the analyzer.This command is only available in the frequency domain (span >0).

Example: `"FREQ:STOP 2000MHz"`

Features: *RST value: f_{max}
SCPI: conforming

Mode A

[SENSe<1|2>:]FREQuency:MODE CW | FIXed | SWEep

This command switches between frequency (SWEep) and time (CW | FIXed) domain in the analyzer mode.

For CW and FIXed, the frequency setting is via command `FREQuency:CENTer`. In the SWEep mode, the setting is via commands `FREQuency:STARt`, `STOP`, `CENTer` and `SPAN`.

Example: `"FREQ:MODE SWE"`

Features: *RST value: SWEep
SCPI: conforming

Mode: A

[SENSe<1|2>:]FREQuency:OFFSet <numeric_value>

This command defines the frequency offset of the instrument.

Example: `"FREQ:OFFS 1GHZ"`

Features: *RST value: 0 Hz
SCPI: conforming

Mode: A

SENSe:POWer Subsystem

This subsystem controls the setting of the instrument's channel and adjacent channel power measurements. The measurement windows are assigned to SENSe1 (screen A) and SENSe2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
[SENSe<1|2>]			
:POWer			
:ACHannel			
:SPACing			
[:ACHannel]	<numeric_value>	HZ	
:ALTernate<1|2>	<numeric_value>	HZ	
:ACPairs	0 | 1 | 2 | 3		
:BANDwidth|:BWIDth			
[:CHANnel]	<numeric_value>	HZ	
:ACHannel	<numeric_value>	HZ	
:ALTernate<1|2>	<numeric_value>	HZ	
:MODE	ABSolute | RELative		
:REFerence			
:AUTO	ONCE		no query
:PRESet	ACPower | CPOWer | OBANdwidth | OBWidth		
:RLEVel			
:BANDwidth	<numeric_value>	PCT	
:BWIDth	<numeric_value>	PCT	
:HSPeed	<Boolean>		
:NCORrection	<Boolean>		
:TRACe	<numeric_value>	--	

[SENSe<1|2>:]POWer:ACHannel:SPACing:ACHannel 100 Hz to 2000 MHz

This command defines the channel spacing of adjacent channel to carrier. At the same time, the spacing of alternate adjacent channels 1 and 2 is set to the double or triple of the entered value.

The command is only available in the frequency domain (span > 0).

Example: `"POW:ACH:SPAC:ACH 33kHz"` Sets the spacing of the carrier signal relative to the adjacent channel to 33 kHz, to 66 kHz relative to alternate adjacent channel 1 and to 99 kHz relative to alternate adjacent channel 2.

Example: `"POW:ACH:SPAC:ACH 338kHz"`

Features: *RST value: 14 kHz
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:ACHannel:SPACing:ALTernate<1|2> 100 Hz to 2000 MHz

This command defines the spacing of the first (ALTernate1) or the second alternate adjacent channel (ALTernate2) relative to the carrier signal.If the spacing to alternate adjacent channel ALTernate1 is modified, the spacing to alternate adjacent channel 2 is set to the 1.5 times the entered value.

The commande is only available in the frequency domain (span > 0).

Example: `"POW:ACH:SPAC:ALT1 99kHz"` Sets the spacing of the carrier signal relative to alternate adjacent channel 1 to 100 kHz and of the carrier signal relative to alternate adjacent channel 2 to 150 kHz.

Features: *RST value: 40 kHz (ALT1)
60 kHz (ALT2)
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:ACHannel:ACPairs 0 | 1..| 2 | 3

This command sets the number of adjacent channels (upper and lower channel in pairs).The figure 0 stands for pure channel power measurement.

The command is only available in the frequency domain (span > 0).

Example: `"POW:ACH:ACP 3"` Sets the number of adjacent channels to 3, ie the adjacent channel and alternate adjacent channels 1 and 2 are switched on.

Features: *RST value: 1
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel] 100 Hz to 1000 MHz

This command sets the channel bandwidth of the radio communication system.The bandwidths of adjacent channels are not influenced by this modification (in contrast to the FSE family).

The command is only available in the frequency domain (span > 0).

Example: `"POW:ACH:BWID 30kHz"` Sets the banwidth of the main channel to 30 kHz.

Features: *RST value: 14 kHz
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel 100 Hz to 1000 MHz

This command defines the channel bandwidth of the adjacent channel of the radio transmission system. If the bandwidth of the adjacent channel is changed, the bandwidths of all alternate adjacent channels are automatically set to the same value.

The command is only available in the frequency domain (span > 0).

Example: `"POW:ACH:BWID:ACH 30kHz"` Sets the bandwidth of all adjacent channels to 30 kHz.

Features: *RST value: 14 kHz
SCPI: device-specific

Mode: A-F

If the bandwidth of the adjacent channel is changed, the bandwiths of all alternate adjacent channels are automatically set to the same value.

[SENSe<1|2>:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<1|2> 100 Hz to 2000 MHz

This command defines the channel bandwidth of the first/second alternate adjacent channel of the radio transmission system.

Example: `"POW:ACH:BWID:ALT2 30kHz"`

Features: *RST value: 14 kHz
SCPI: device-specific

Mode: A-F

If the channel bandwidth of alternate adjacent channel 1 is changed, the bandwith of alternate adjacent channel 2 is automatically set to the same value.

[SENSe<1|2>:]POWer:ACHannel:MODE ABSolute | RELative

This command toggles between absolute and relative adjacent channel measurement.

For the relative measurement the reference value is set to the currently measured channel power by command `SENSe:POWer:ACHannel:REFerence:AUTO ONCE`.

The command is only available in the frequency domain (span > 0).

Example: `"POW:ACH:MODE REL"`

Features: *RST value: ABSolute
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:ACHannel:REFerence:AUTO ONCE

This command sets the reference value for the relative measurement to the currently measured channel power.

The command is only available in the frequency domain (span > 0).

Example: `"POW:ACH:REF:AUTO ONCE"`

Features: *RST value: -
SCPI: device-specific

Mode: A-F

This command is an event and is therefore not assigned an *RST value and has no query.

[SENSe<1|2>:]POWer:ACHannel:PRESet ACPower | CPOWer | OBANdwidth|OBWidth

This command adapts the frequency domain (span), the bandwidths and the detector to the number of channels, channel bandwidths and channel spacings of the active power measurement and switches on the adjacent channel power measurement, if required.

To ensure that the results are valid, a complete sweep should be performed after setting as well as synchronization to the sweep end. Synchronization is only possible in the single-sweep mode.

The results are queried with `CALCulate:MARKer:FUNCtion:POWer:RESult?`.

The command is only available in the frequency domain (span > 0).

Example:

`"POW:ACH:REF:PRES ACP"`	Sets the frequency range, bandwidths and detector adapted to ACP measurement in screen A.
`"INIT:CONT OFF"`	Switches to single-sweep mode.
`"INIT;*WAI"`	Starts a sweep and waits for the end.
`"CALC:MARK:FUNC:POW:RES? ACP"`	Queries the result of the adjacent channel power measurement.

Features: *RST value: -
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:ACHannel:PRESet:RLEVel

This command adapts the reference level of FSP to the measured channel power and switches on previously the adjacent channel power measurement, if required. This ensures that the signal path of FSP is not overloaded. Since the measurement bandwidth is significantly smaller than the signal bandwidth in channel power measurements, the signal path can be overloaded although the trace is still much below the reference level. When the measured channel power equals the reference level, the signal path is not overloaded.

The command is only available in the frequency domain (span > 0).

Example:

`"POW:ACH:REF:PRES:RLEV"`	Adapts the reference level to the measured channel power.

Features: *RST value: -
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:BANDwidth|BWIDth 10 to 99.9PCT

This command defines the percentage of the power with respect to the total power. This value defines the occupied bandwidth (measurement `POWer:ACHannel:PRESet OBW`).

The command is only available in the frequency domain (span > 0).

Example: `"POW:BWID 95PCT"`

Features: *RST value: 99PCT
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:HSPeed ON | OFF

This command switches on or off the high-speed channel/adjacent channel power measurement. The measurement itself is performed in the time domain on the center frequencies of the different channels. The command automatically switches to the time domain and back.

Depending on the selected mobile radio standard, weighting filters with √cos characteristic or very steep-sided channel filters are used for band limitation. If no standard is selected, weighting is performed by means of the normal resolution filters.

The command is only available in the frequency domain (span > 0). It is not available for the following selection of standards: `CALCulate:POWer:ACHannel:PRESet NONE` or `FWCDma` or `RWCDma`.

Example: `"POW:HSP ON"`

Features: *RST value: OFF
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:NCORrection ON | OFF

This command switches on or off the correction of the instrument inherent noise for channel power measurement and measurement of the occupied bandwidth. On activating this function, a reference measurement of the instrument inherent noise is performed. The measured noise power is then subtracted from the power in the examined channel.
The instrument inherent noise is then re-determined after any change of the center frequency, resolution bandwidth, sweep time and level setting by repeating the reference measurement in the new instrument setting.

The command is only available in the frequency domain (span > 0).

Example: `"POW:NCOR ON"`

Features: *RST value: OFF
SCPI: device-specific

Mode: A-F

[SENSe<1|2>:]POWer:TRACe 1 to 3

This command assigns the channel/adjacent channel power measurement of the indicated trace in the selected measurement window. The corresponding trace should be active, ie its states should differ from blank.

Note: *The measurement of the occupied bandwidth (OBW) is performed on the trace on which marker 1 is positioned. To evaluate another trace, marker 1 should be positioned to another trace with* `CALCulate :MARKer:TRACe 1|2|3`.

Example: `"POW:TRAC 2"` Assigns the measurement in screen A to trace 2.
`"SENS2:POW:TRAC 3"` Assigns the measurement in screen B to trace 3.

Features: *RST value: -
SCPI: device-specific

Mode: A

SENSe:ROSCillator Subsystem

This subsystem controls the reference oscillator. The numeric suffix in SNESe is irrelevant for the commands of this subsystem.

COMMAND	PARAMETERS	UNIT	COMMENT
[SENSe<1|2>]			
:ROSCillator			
:SOURce	INTernal | EXTernal	--	
[:INTernal]			
:TUNe	<numeric_value>		
:SAVe			no query

[SENSe<1|2>:]ROSCillator:SOURce INTernal | EXTernal

This command controls selection of the reference oscillator.

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

Example: `"ROSC:SOUR EXT"`

Features: *RST value: –
SCPI: conforming

Mode: all

*RST has no influence on this setting.

[SENSe<1|2>:]ROSCillator[:INTernal]:TUNe 0 to 4095

This command defines the value for the tuning of the internal reference oscillator.

The reference oscillator should be tuned only if an error has been detected in the frequency accuracy check. After switching on the instrument, the factory-set reference frequency or the saved value of the reference frequency is restored.

Note: *This command is only available at service level 1.*

Example: `"ROSC:TUN 128"`

Features: *RST value: –
SCPI: device-specific

Mode: all

[SENSe<1|2>:]ROSCillator[:INTernal]:TUNe:SAVe

This command saves the new value for the tuning of the internal reference oscillator. The factory-set value in the EEPROM is overwritten.

Note: *This command is only available at service level 1.*

Example: `"ROSC:TUN:SAV"`

Features: *RST value: –
SCPI: device-specific

Mode: all

SENSe:SWEep Subsystem

This subsystem controls the sweep parameters. The measurement windows are assigned to SENSe1 (screen A) and SENSe2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
[SENSe<1|2>]			
:SWEep			
:TIME	<numeric_value>	S	
:AUTO	<Boolean>	--	
:COUNt	<numeric_value>	--	
:EGATe	<Boolean>	--	
:TYPE	LEVel|EDGE	--	
:POLarity	POSitive|NEGative	--	
:HOLDoff	<numeric_value>	S	
:LENGth	<numeric_value>	S	
:SOURce	EXTernal | IFPower		

[SENSe<1|2>:]SWEep:TIME <numeric_value>

This command defines the sweep time. The settable time values are different in the frequency domain (2.5 ms to 16000s with span > 0) and in the time domain (1µs to 16000s with span = 0).

Example: `"SWE:TIME 10s"`

Features: *RST value - (AUTO is set to ON)
SCPI: conforming

Mode: A

If `SWEep:TIME` is directly programmed, automatic coupling is switched off.

[SENSe<1|2>:]SWEep:TIME:AUTO ON | OFF

This command switches the automatic coupling of the sweep time for the frequency span or bandwidth settings..

If `SWEep:TIME` is directly programmed, automatic coupling is switched off.

Example: `"SWE:TIME:AUTO ON"` Switches on the coupling to frequency domain and bandwidths.

Features: *RST value: ON
SCPI: conforming

Mode: A

[SENSe<1|2>:]SWEep:COUNt 0 to 32767

This command defines the number of sweeps started with single sweepand which are used for calculating the average or maximum value. In the average mode, the value 0 defines a running averaging of measurement data over 10 sweeps..

Example:
```
"SWE:COUN 64"      Sets the number of sweeps to 64.
"INIT:CONT OFF"    Switches to single-sweep mode.
"INIT;*WAI"        Starts a sweep and waits for the end.
```

Features: *RST value: 0
SCPI: conforming

Mode: A

[SENSe<1|2>:]SWEep:EGATe ON | OFF

This command switches on the external gate signal.

In case of measurement with external gate, the measured values are recorded until the gate is opened. There are two possibilities:

1. The gate is edge-triggered (`"SWEep:EGATe:TYPE EDGE"`):
   After detection of the set gate signal edge, the gate remains open until the gate delay (`SWEep:EGATe:HOLDoff`) has elapsed.
2. The gate is level-triggered (`"SWEep:EGATe:TYPE EDGE"`):
   After detection of the gate signal, the gate remains open until the gate signal disappears.

A delay between applying the gate signal and the start of recording measured values can be defined with `SWEep:EGATe:HOLDoff`.

During a sweep the gate can be opened and closed several times. The synchronization mechanisms with *OPC, *OPC? and *WAI remains completely unaffected.

The sweep end is detected when the required number of test points (501 in analyzer mode) has been recorded.

Example:

`"SWE:EGAT ON"`	Switches on the mode with external gate.
`"SWE:EGAT:TYPE EDGE"`	Switches on the edge-triggered mode.
`"SWE:EGAT:HOLD 100US"`	Sets the gate delay to 100 µs.
`"SWE:EGAT:LEN 500US"`	Sets the gate opening time to 500 µs.
`"INIT;*WAI"`	Starts a sweep and waits for the end.

Features: *RST value: OFF
SCPI: device-specific

Mode: A

[SENSe<1|2>:]SWEep:EGATe:TYPE LEVel | EDGE

This command sets the type of triggering (level or edge) by the external gate signal.

The gate opening time cannot be defined with the parameter `EGATe:LENGth` in case of level triggering. The gate is closed when the gate signal disappears.

Example: `"SWE:EGAT:TYPE EDGE"`

Features: *RST value: EDGE
SCPI: device-specific

Mode: A

[SENSe<1|2>:]SWEep:EGATe:POLarity POSitive | NEGative

This command determines the polarity of the external gate signal. The setting is valid both for the edge of an edge-triggered signal and the level of a level-triggered signal.

Example: `"SWE:EGAT:POL POS"`

Features: *RST value: POSitive
SCPI: device-specific

Mode: A

[SENSe<1|2>:]SWEep:EGATe:HOLDoff 0 to 100s

This command defines the delay time between the external gate signal and the continuation of the sweep.

Example: `"SWE:EGAT:HOLD 100us"`

Features: *RST value: 0s
SCPI: device-specific

Mode: A

[SENSe<1|2>:]SWEep:EGATe:LENGth 0 to 100s

In case of edge triggering, this command determines the time interval in which the instrument sweeps.

Example: `"SWE:EGAT:LENG 10ms"`

Features: *RST value: 0s
SCPI: device-specific

Mode: A

The values for the delay time can be set in steps 1, 2, 3 and 5.

[SENSe<1|2>:]SWEep:EGATe:SOURce EXTernal | RFPower

This command toggles between external gate signal and IF power signal as a signal source for the gate mode. If an IF power signal is used, the gate is opened as soon as a signal is detected within the IF path bandwidth (10 MHz).

Example: `"SWE:EGAT:SOUR IFP"` Switches the gate source to IF power.

Features: *RST value: IFPower
SCPI: device-specific

Mode: A

STATus Subsystem

The STATus subsystem contains the commands for the status reporting system (see Section 3.8, Status Reporting System"). *RST does not influence the status registers.

COMMAND	PARAMETERS	UNIT	COMMENT
STATus			
:OPERation			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:PRESet	--	--	
:QUEStionable			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:POWer			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:LIMit			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:LMARgin			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:ACPLimit			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:FREQuency	--	--	
[:EVENt]?	0 to 65535	--	
:CONDition?	0 to 65535	--	
:ENABle	0 to 65535	--	
:PTRansition	--	--	
:NTRansition	--	--	
:QUEue?	--	--	
[:NEXT]?	--	--	

STATus:OPERation[:EVENt]?

This command queries the contents of the EVENt section of the STATus:OPERation register. The contents of the EVENt section is deleted with readout.

Example: "STAT:OPER?"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:OPERation:CONDition?

This command queries the CONDition section of the STATus:OPERation register. Readout does not delete the contents of the CONDition section. The value returned reflects the current hardware status.

Example: "STAT:OPER:COND?"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:OPERation:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable register. The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

Example: "STAT:OPER:ENAB 65535"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:OPERation:PTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:OPERation register from 0 to 1 for the transitions of the CONDition bit.

Example: "STAT:OPER:PTR 65535"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:OPERation:NTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:OPERation register from 1 to 0 for the transitions of the CONDition bit.

Example: "STAT:OPER:NTR 65535"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:PRESet

This command resets the edge detectors and ENABle parts of all registers to a defined value. All PTRansition parts are set to FFFFh, ie all transitions from 0 to 1 are detected. All NTRansition parts are set to 0, ie a transition from 1 to 0 in a CONDition bit is not detected. The ENABle part of the STATus:OPERation and STATus:QUEStionable registers are set to 0, ie all events in these registers are not passed on.

Example: `"STAT:PRES"`

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionable register. Readout deletes the contents of the EVENt section.

Example: `"STAT:QUES?"`

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:CONDition?

This command queries the CONDition section of the STATus:QUEStionable register. Readout does not delete the contents of the CONDition section.

Example: `"STAT:QUES:COND?"`

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus-QUEStionable register.The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

Example: `"STAT:QUES:ENAB 65535"`

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:PTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:OPERation register from 0 to 1 for the transitions of the CONDition bit.

Example: `"STAT:QUES:PTR 65535"`

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:NTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:OPERation register from 1 to 0 for the transitions of the CONDition bit.

Example: "STAT:QUES:NTR 65535"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:POWer[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionable:POWer register. Readout deletes the contents of the EVENt section.

Example: "STAT:QUES?"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:POWer:CONDition?

This command queries the content of the CONDition section of the STATus:QUEStionable:POWer register. Readout does not delete the contents of the CONDition section.

Example: "STAT:QUES:COND?"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:POWer:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:POWer register. The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

Example: "STAT:QUES:ENAB 65535"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:POWer:PTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable:POWer register from 0 to 1 for the transitions of the CONDition bit.

Example: "STAT:QUES:PTR 65535"

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:POWer:NTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable:POWer register from 1 to 0 for the transitions of the CONDition bit.

Example: `"STAT:QUES:NTR 65535"`

Features: *RST value: –
SCPI: conforming

Mode: all

STATus:QUEStionable:LIMit[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionable:LIMit register. Readout deletes the contents of the EVENt section.

Example: `"STAT:QUES?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LIMit:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:LIMit register.

Example: `"STAT:QUES:COND?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

Readout does not delete the contents of the CONDition section.

STATus:QUEStionable:LIMit:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable register.The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

Example: `"STAT:QUES:ENAB 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LIMit:PTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable:LIMit register from 0 to 1 for the transitions of the CONDition bit.

Example: `"STAT:QUES:PTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LIMit:NTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable:LIMit register from 1 to 0 for the transitions of the CONDition bit.

Example: `"STAT:QUES:NTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LMARgin[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionable:LMARgin register. Readout deletes the contents of the EVENt section.

Example: `"STAT:QUES?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LMARgin:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:LMARgin register. Readout does not delete the contents of the CONDition section.

Example: `"STAT:QUES:COND?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LMARgin:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:LMARgin register. The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

Example: `"STAT:QUES:ENAB 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LMARgin:PTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable: LMARgin register from 0 to 1 for the transitions of the CONDition bit.

Example: `"STAT:QUES:PTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:LMARgin:NTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable: LMARgin register from 1 to 0 for the transitions of the CONDition bit.

Example: `"STAT:QUES:NTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:ACPLimit[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionable:ACPLimit register. Readout deletes the contents of the EVENt section.

Example: `"STAT:QUES:ACPL?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:ACPLimit:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:ACPLimit register. Readout does not delete the contents of the CONDition section.

Example: `"STAT:QUES:ACPL:COND?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:ACPLimit:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:ACPLimit register. The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

Example: `"STAT:QUES:ACPL:ENAB 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:ACPLimit:PTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable: ACPLimit register from 0 to 1 for the transitions of the CONDition bit.

Example: `"STAT:QUES:ACPL:PTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:ACPLimit:NTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable: ACPLimit register from 1 to 0 for the transitions of the CONDition bit.

Example: `"STAT:QUES:ACPL:NTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:FREQuency[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionableFREQuency register.

Example: `"STAT:QUES:FREQ?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

Readout deletes the contents of the EVENt section.

STATus:QUEStionable:FREQuency:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:FREQuency register. Readout does not delete the contents of the CONDition section.

Example: `"STAT:QUES:FREQ:COND?"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:FREQuency:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:FREQuency register. The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

Example: `"STAT:QUES:FREQ:ENAB 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:FREQuency:PTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable:FREQuency register from 0 to 1 for the transitions of the CONDition bit.

Example: `"STAT:QUES:FREQ:PTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEStionable:FREQuency:NTRansition 0 to 65535

This command sets the edge detectors of all bits of the STATus:QUEStionable:FREQuency register from 1 to 0 for the transitions of the CONDition bit.

Example: `"STAT:QUES:FREQ:NTR 65535"`

Features: *RST value: –
SCPI: device-specific

Mode: all

STATus:QUEue[:NEXT]?

This command queries the earliest entry to the error queue, thus deleting it.

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI (cf. Chapter 9). If the error queue is empty, the error number 0, "no error", is returned. This command is identical with the command `SYSTem:ERRor`.

Example: `"STAT:QUE?"`

Features: *RST value: –
SCPI: conforming

Mode: all

SYSTem Subsystem

This subsystem comprises a series of commands for general functions.

COMMAND	PARAMETERS	UNIT	COMMENT
SYSTem			
:COMMunicate			
:GPIB			
[:SELF]			
:ADDRess	0 to 30	--	
:RTERminator	LFEoi | EOI		
:SERial			
:CONTrol			
:DTR	IBFull | OFF		
:RTS	IBFull | OFF		
[:RECeive]			
:BAUD	<numeric_value>	--	
:BITS	7 | 8	--	
:PARity			
[:TYPE]	EVEN | ODD | NONE		
:SBITs	1 | 2	--	
:PACE	XON | NONE		
:PRINter			
:ENUMerate			
[:NEXT?]			only query
:FIRSt?			only query
:SELect	<printer_name>		
:DATE	<num>, <num>, <num>	--	
:DISPlay			
:UPDate	<Boolean>		
:ERRor?	--	--	only query
:PASSword			
[:CENable]	<string>		no query
:PRESet	--	--	no query
:SET	<block>		
:SPEaker			audio demodulator option
:VOLume	<numeric_value>	--	
:TIME	0 to 23, 0 to 59, 0 to 59	--	
:VERSion?	--	--	only query

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 0 to 30

This command changes the IEC/IEEE-bus address of the unit.

Example: `"SYST:COMM:GPIB:ADDR 18"`

Features: *RST value: - (no influence on this parameter)
SCPI: conforming

Mode: all

SYSTem:COMMunicate:GPIB[:SELF]:RTERminator LFEOI | EOI

This command changes the delimiter. According to the standard the delimiter in ASCII is <LF> and/or <EOI>. For binary data transmission (eg trace data) to the instrument, the binary code (0AH) used for <LF> can be included in the binary data block, but should not be interpreted as a delimiter in this particular case. This can be obtained by changing the receive delimiter to EOI.

Output of binary data from the instrument does not require such a switching.

Example: `"SYST:COMM:GPIB:RTER EOI"`

Features: *RST value: LFEOI
SCPI: device-specific

Mode: all

SYSTem:COMMunicate:SERial:CONTrol:DTR IBFull | OFF
SYSTem:COMMunicate:SERial:CONTrol:RTS IBFull | OFF

These commands switch the hardware handshake procedure for the serial interface off (OFF) or on (IBFull).

Examples: `"SYST:COMM:SER:CONT:DTR OFF"`
`"SYST:COMM:SER:CONT:RTS IBF"`

Features: *RST value: OFF
SCPI: conforming

Mode: all

SYSTem:COMMunicate:SERial[:RECeive]:BAUD 110 | 300 | 600 | 1200 | 2400 | 9600 | 19200

This command sets the transmission speed for the serial interface (COM).

Example: `"SYST:COMM:SER:BAUD 2400"`

Features: *RST value: 9600
SCPI: conforming

Mode: all

SYSTem:COMMunicate:SERial[:RECeive]:BITS 7 | 8

This command defines the number of data bits per data word for the serial interface (COM).

Example: `"SYST:COMM:SER:BITS 7"`

Features: *RST value: 8
SCPI: conforming

Mode: all

SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE] EVEN | ODD | NONE

This command defines the parity check for the serial interface (COM).

Example: `"SYST:COMM:SER:PAR EVEN"`

Features: *RST value: NONE
SCPI: conforming

Mode: all

Permissible values are:
EVEN even parity
ODD odd parity
NONE no parity check.

SYSTem:COMMunicate:SERial[:RECeive]:SBITs 1|2

This command defines the number of stop bits per data word for the serial interface (COM).

Example: `"SYST:COMM:SER:SBITs 2"`

Features: *RST value: 1
SCPI: conforming

Mode: all

SYSTem:COMMunicate:SERial[:RECeive]:PACE XON | NONE

This command switches on or off the software handshake for the given serial interface.

Example: `"SYST:COMM:SER:PACE XON"`

features: *RST value: NONE
SCPI: conforming

Mode: all

SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?

This command queries the name of the first printer (in the list of printers) under Windows NT.

The names of other installed printers can be queried with command `SYSTem:COMMunicate:PRINter:ENUMerate:NEXT?`.

If no printer is configured an empty string is output.

Example: `"SYST:COMM:PRIN:ENUM:FIRS?"`

Features: *RST value: -
SCPI: device-specific

Mode: all

SYSTem:COMMunicate:PRINter:ENUMerate:NEXT?

This command queries the name of the next printer installed under Windows NT.

The command

`SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?`

should be sent previously to return to the beginning of the printer list and query the name of the first printer.

The names of other printers can then be queried with NEXT?. After all available printer names have been output, an empty string enclosed by quotation marks (") is output for the next query. Further queries are answered with Query Error.

Example: `"SYST:COMM:PRIN:ENUM:NEXT?"`

Features: *RST value: -
SCPI: device-specific

Mode: all

SYSTem:COMMunicate:PRINter:SELect <printer_name>

This command selects one of the printers installed under Windows NT including the associated output medium.

The name of the first printer is queried with `FIRSt?`. After that the names of other installed printers can be queried with `NEXT?`.

Parameter: <printer_name> ::= string which has been queried with commands `SYSTem:COMMunicate :PRINter:ENUMerate:FIRSt?` and `NEXT?`.

Note: *Command `HCOPy:DESTination` is used to select an output medium other than the preset one.*

Example: `"SYST:COMM:PRIN:SEL 'LASER on LPT1'"`

Features: *RST value: -
SCPI: device-specific

Mode: all

SYSTem:DATE 1980 to 2099, 1 to 12, 1 to 31

This command is used to enter the date for the internal calendar.

The sequence of entry is year, month, day.

Example: `" SYST:DATE 1994,12,1"`

Features: *RST value: –
SCPI: conforming

Mode: all

SYSTem:DISPlay:UPDate ON | OFF

This command switches on or off the update of all display elements during remote control.

Note: *The best performance is obtained when the display output is switched off during remote control.*

Example: `" SYST:DISP:UPD ON`

Features: *RST value: OFF
SCPI: device specific

Mode: all

SYSTem:ERRor?

This command queries the earliest entry to the error queue, thus deleting it. .

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI (cf. Chapter 9). If the error queue is empty, the error number 0, "no error", is returned. This command is identical with the command `STATus:QUEue:NEXT?`. This command is a query and is therefore not assigned an *RST value.

Example: `"SYST:ERR?"`

Features: *RST value: –
SCPI: conforming

Mode: all

SYSTem:PASSword[:CENable] <string>

This command enables access to the service functions by means of the password.

Example: `"SYST:PASS 'XXXX'"`

Features: *RST value: –
SCPI: conforming

Mode: all

This command is an event and is therefore not assigned an *RST value and has no query.

SYSTem:PRESet

This command triggers an instrument reset.

Example: `"SYST:PRES"`

Features: *RST value: –
SCPI: conforming

Mode: all

The effect of this command corresponds to that of the *PRESET* key with manual control or to the *RST command.

SYSTem:SET <block>

The query SYSTem:SET? causes the data of the current instrument setting to be transmitted to the controller in binary form (SAVE function). The data can be read back into the instrument (RECALL function) by means of command SYSTem:SET <block>. If the data records are stored on the instrument harddisk with SAVE/RECALL (MMEMory:STORe bzw. MMEMory:LOAD), it is possible to store the data in an external computer by means of SYSTem:SET.

Example: "SYST:SET "

Features: *RST value: –
SCPI: conforming

Mode: all

The receive terminator has to be set to EOI to ensure reliable transfer of data (setting SYST:COMM:GPIB:RTER EOI).

SYSTem:SPEaker:VOLume 0 to 1

This command sets the volume of the built-in loudspeaker for demodulated signals. Minimum volume is set by 0 and maximum volume by 1.

The value 0 is the lowest volume, the value 1 the highest volume.

Example: "SYST:SPE:VOL 0.5"

Features: *RST value: 0
SCPI: device-specific

Mode: all

The command is only available with the audio demodulator option (FSP-B3).

SYSTem:TIME 0 to 23, 0 to 59, 0 to 59

This command sets the internal clock. The sequence of entry is hour, minute, second.

Example: "SYST:TIME 12,30,30"

Features: *RST value: –
SCPI: conforming

Mode: all

SYSTem:VERSion?

This command queries the number of the SCPI version, which is relevant for the instrument.

Example: "SYST:VERS?"

Features: *RST value: –
SCPI: conforming

Mode: all

This command is a query and is therefore not assigned an *RST value.

TRACe Subsystem

The TRACe subsystem controls access to the instrument's internal trace memory.

COMMAND	PARAMETERS	UNIT	COMMENT
TRACe<1|2>			
[:DATA]	TRACE1|TRACE2|TRACE3,<block>|<numeric_value>...	-	
:COPY	TRACE1|TRACE2|TRACE3, TRACE1|TRACE2|TRACE3	-	

TRACe[:DATA] TRACE1| TRACE2| TRACE3, <block> | <numeric_value>

This command transfers trace data from the controller to the instrument, the query reads trace data out of the instrument. The associated measurement window is selected with the numeric suffix of TRACe<1|2>.

Example: `"TRAC TRACE1,"+A$  (A$: data list in the current format)`
`"TRAC? TRACE1"`

Features: *RST value: -
SCPI: conforming

Mode: all

The trace data are transferred in the current format (corresponding to the command FORMat ASCiilREAL). The device-internal trace memory is addressed using the trace names 'TRACE1' to 'TRACE3'.
The transfer of trace data from the controller to the instrument takes place by indicating the trace name and then the data to be transferred. In ASCII format, these data are values separated by commas. If the transfer takes place using the format real (REAL 32), the data are transferred in block format.

The parameter of the query is the trace name TRACE1 to TRACE3, it indicates which trace memory will be read out.

Saving and recalling trace data together with the device settings to/from the device-internal hard disk or to/from a floppy is controlled via the commands "`MMEMory:STORe:STATe`" and "`MMEMory:LOAD:STATe`" respectively. Trace data are selected with "`MMEMory:SELect[:ITEM]:ALL`" or ""`MMEMory:SELect[:ITEM]:TRACe`". Trace data in ASCII format (ASCCII FILE EXPORT) are exported with the command "`MMEM:STORe:TRACe`".

The transfer format for the trace data depends on the instrument setting

Analyzer mode (span >0 and zero span):

500 results are output in the unit selected for display.

Note: *With AUTO PEAK detector, only positive peak values can be read out. Trace data can be read into instrument with logarithmic display only in dBm, with linear display only in volts.*

FORMAT REAL,32 is to be used as format for binary transmission.

TRACe:COPY TRACe:COPY TRACE1| TRACE2| TRACE3| TRACE4 ,
TRACE1| TRACE2| TRACE3| TRACE4

This command copies data from one trace to another. The second operand designates the source, the first operand the destination of the data to be copied.The associated measurement window is selected with the numeric suffix of TRACe<1|2>.

Example: `"TRAC:COPY TRACE1,TRACE2"`

Features: *RST value:
SCPI: conforming

Mode: all

This command is an event and therefore has no query and no *RST value assigned.

TRIGger Subsystem

The TRIGger subsystem is used to synchronize instrument actions with events. It is thus possible to control and synchronize the start of a sweep. An external trigger signal can be fed to the connector at the rear panel of the instrument. A distinction is made between TRIGger1 (screen A) and TRIGger2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
TRIGger<1|2>			
[:SEQuence]			
:SOURce	IMMediate | VIDeo | IFPower | EXTernal		
:VIDeo	<numeric_value>	PCT	
:HOLDoff	<numeric_value>	S	
:SLOPe	POSitive|NEGative	--	

TRIGger<1|2>[:SEQuence]:SOURce IMMediate | EXTernal | VIDeo | IFPower

This command selects the trigger source for the start of a sweep.

Parameter:

IMMediate = automatic triggering the next measurement at the end of the previous one.The value IMMediate corresponds to the FREE RUN setting.

EXTernal = the next measurement is triggered by the signal at the external trigger input.

VIDeo = the next measurement is triggered by the detection of a signal at the video filter output.

IFPower = the next measurement is triggered by the detectíon of a signal at the instrument IF (10 MHz bandwidth)

Example: `"TRIG:SOUR EXT"`

Features: *RST value: IMMediate
SCPI: conforming

Mode: all

TRIGger<1|2>[:SEQuence]:LEVel:VIDeo 0 to 100PCT

This command sets the level of the video trigger source.

Example: `"TRIG:LEV:VID 50PCT"`

Features: *RST value: 50 PCT
SCPI: device-specific

Mode: all

TRIGger<1|2>[:SEQuence]:HOLDoff -100 to 100s

This command defines the length of the trigger delay.

A negative delay time (pretrigger) can be set in the time domain (span < 0 Hz) only. The maximum permissible range and the maximum effective resolution of the pretrigger are limited by the set sweep time (max range= - 499/500 x sweep time; max. resolution = sweep time/500). Pretriggering is not possible when the rms or the average detector is activated.

Example: `"TRIG:HOLD 500us"`

Features: *RST value: 0s
SCPI: conforming

Mode: alle

TRIGger<1|2>[:SEQuence]:SLOPe POSitive | NEGative

This command selects the slope of the trigger signal. The selected trigger slope applies to all trigger signal sources .

Exapmple: `"TRIG:SLOP NEG"`

Features: *RST value: POSitive
SCPI: conforming

Mode: alle

UNIT Subsystem

The UNIT subsystem is used to switch the basic unit of setting parameters. A distinction is made between UNIT1 (screen A) and UNIT2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
UNIT<1|2> :POWer	DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere		

UNIT<1|2>:POWer DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | V | A | W

This command selects the default unit for the selected measurement window.

Example: `"UNIT:POW DBUV"` Sets the power unit for screen A to dBm.

Features: *RST value: DBM
SCPI: conforming

Mode: A

Alphabetical List of Commands

In the following, all remote-control commands are listed with their parameters and page numbers. Generally, they are arranged alphabetically according to the keywords of the command. The list of common commands starts the table.

Command	Parameter	Page
*CAL?		6.4
*CLS		6.4
*ESE	0 to 255	6.4
*ESR?		6.4
*IDN?		6.4
*IST?		6.4
*OPC		6.4
*OPT?		6.4
*PCB	0 to 30	6.4
*PRE	0 to 255	6.4
*PSC	0 | 1	6.4
*RST		6.4
*SRE	0 to 255	6.4
*STB?		6.4
*TRG		6.4
*TST?		6.4
*WAI		6.4
ABORt		6.7
CALCulate<1|2>:DELTamarker<1 to 4>:AOFF		6.9
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:X	<numeric_value>	6.14
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y		6.13
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y:OFFSet	<numeric_value>	6.13
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed[:STATe]	ON | OFF	6.13
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:PNOise:RESult?		6.14
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:PNOise[:STATe]	ON | OFF	6.14
CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:LEFT		6.11
CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:NEXT		6.11
CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum[:PEAK]		6.10
CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:RIGHt		6.11
CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:LEFT		6.12
CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:NEXT		6.12
CALCulate<1|2>:DELTamarker<1 to 4>:MINimum[:PEAK]		6.11
CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:RIGHt		6.12
CALCulate<1|2>:DELTamarker<1 to 4>:MODE	ABSolute | RELative	6.9
CALCulate<1|2>:DELTamarker<1 to 4>[:STATe]	ON | OFF	6.8
CALCulate<1|2>:DELTamarker<1 to 4>:TRACe	1 to 3	6.9
CALCulate<1|2>:DELTamarker<1 to 4>:X	0 to MAX (frequency | sweep time)	6.9
CALCulate<1|2>:DELTamarker<1 to 4>:X:RELative?		6.10
CALCulate<1|2>:DELTamarker<1 to 4>:Y?		6.10
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:ABSolute	-200 to 200 DBM, -200 to 200 DBM	6.22

Command	Parameter	Page
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:ABSolute:STATe	ON | OFF	6.23
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:RESult?		6.24
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel[:RELative]	0 to 100 dB, 0 to 100 dB	6.20
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel[:RELative]:STATe	ON | OFF	6.21
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:ABSolute	-200 to 200 DBM, -200 to 200 DBM	6.27
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:ABSolute:RESult?		6.29
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:ABSolute:STATe	ON | OFF	6.28
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>[:RELative]	0 to 100 DB, 0 to 100 DB	6.25
CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:STATe[:RELative]	ON | OFF	6.26
CALCulate<1|2>:LIMit<1 to 8>:ACPower[:STATe]	ON | OFF	6.19
CALCulate<1|2>:LIMit<1 to 8>:CLEar[:IMMediate]		6.17
CALCulate<1|2>:LIMit<1 to 8>:COMMent	<string>	6.17
CALCulate<1|2>:LIMit<1 to 8>:CONTrol[:DATA]	<numeric_value>, <numeric_value>..	6.30
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:DOMain	FREQuency | TIME	6.30
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:MODE	RELative | ABSolute	6.31
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:OFFset	<numeric_value>	6.31
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:SHIFt	<numeric_value>	6.31
CALCulate<1|2>:LIMit<1 to 8>:COPY	1 to 8 | <name>	6.18
CALCulate<1|2>:LIMit<1 to 8>:DELete		6.18
CALCulate<1|2>:LIMit<1 to 8>:FAIL?		6.17
CALCulate<1|2>:LIMit<1 to 8>:LOWer[:DATA]	<numeric_value>	6.32
CALCulate<1|2>:LIMit<1 to 8>:LOWer:MARGin	<numeric_value>	6.33
CALCulate<1|2>:LIMit<1 to 8>:LOWer:MODE	RELative | ABSolute	6.33
CALCulate<1|2>:LIMit<1 to 8>:LOWer:OFFset	<numeric_value>	6.33
CALCulate<1|2>:LIMit<1 to 8>:LOWer:SHIFt	<numeric_value>	6.34
CALCulate<1|2>:LIMit<1 to 8>:LOWer:STATe	ON | OFF	6.33
CALCulate<1|2>:LIMit<1 to 8>:LOWer:THReshold	<numeric value>	6.34
CALCulate<1|2>:LIMit<1 to 8>:NAME	1 to 8 | <string>	6.18
CALCulate<1|2>:LIMit<1 to 8>:STATe	ON | OFF	6.16
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TRIGger<1|2>[:SEQuence]:SLOPe	POSitive | NEGative	6.141
TRIGger<1|2>[:SEQuence]:SOURce	IMMediate | EXTernal | VIDeo | IFPower	6.140
UNIT<1|2>:POWer	DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMP | V | A | W	6.142

Table of Softkeys with IEC/IEEE-Bus Command Assignment

FREQUENCY Key

FREQ	
CENTER	[SENSe:]FREQuency:CENTer <num_value>
CF-SREPSIZE	
0.1 * SPAN	[SENSe:]FREQuency:CENTer:STEP:LINK SPAN; [SENSe:]FREQuency:CENTer:STEP:LINK:FACTor 10PCT
0.5 * SPAN	[SENSe:]FREQuency:CENTer:STEP:LINK SPAN; [SENSe:]FREQuency:CENTer:STEP:LINK:FACTor 50PCT
X * SPAN	[SENSe:]FREQuency:CENTer:STEP:LINK SPAN; [SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <num_value>
0.1 * RBW	[SENSe:]FREQuency:CENTer:STEP:LINK RBW; [SENSe:]FREQuency:CENTer:STEP:LINK:FACTor 10PCT
0.5 * RBW	[SENSe:]FREQuency:CENTer:STEP:LINK RBW; [SENSe:]FREQuency:CENTer:STEP:LINK:FACTor 50PCT
X * RBW	[SENSe:]FREQuency:CENTer:STEP:LINK RBW; [SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <num_value>
= CENTER	no corresponding IEC/IEEE-bus command
= MARKER	no corresponding IEC/IEEE-bus command
MANUAL	[SENSe:]FREQuency:CENTer:STEP <num_value>
START	[SENSe:]FREQuency:STARt <num_value>
STOP	[SENSe:]FREQuency:STOP <num_value>
FREQUENCY OFFSET	[SENSe:]FREQuency:OFFSet <num_value>
SIGNAL TRACK	
TRACK ON OFF	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack[:STATe] ON | OFF
TRACK BW	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack:BANDwidth <num_value>
TRACK THRESHOLD	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack:THReshold <num_value>
SELECT TRACE	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:STRack:TRACe 1 | 2 | 3

SPAN Key

SPAN	
SPAN MANUAL	`[SENSe:]FREQuency:SPAN <num_value>`
SWEEPTIME MANUAL	`[SENSe:]SWEeptime <num_value>`
FULL SPAN	`[SENSe:]FREQuency:SPAN:FULL`

ZERO SPAN	`[SENSe:]FREQuency:SPAN 0HZ`
	or
	`[SENSe:]FREQuency:MODE CW | FIXed`

LAST SPAN	no corresponding IEC/IEEE-bus command

AMPT Key

AMPT	
REF LEVEL	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:RLEVel <num_value>
RANGE LOG 100 dB	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y:SPACing LOGarithmic; DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe] 100 dB
RANGE LOG MANUAL	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y:SPACing LOGarithmic; DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe] <num_value>
RANGE LINEAR	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y:SPACing LINear
UNIT	
dBm	CALCulate<1|2>:UNIT:POWer DBM
dBmV	CALCulate<1|2>:UNIT:POWer DBMV
dBµV	CALCulate<1|2>:UNIT:POWer DBUV
dBµA	CALCulate<1|2>:UNIT:POWer DBUA
dBpW	CALCulate<1|2>:UNIT:POWer DBPW
VOLT	CALCulate<1|2>:UNIT:POWer VOLT
AMPERE	CALCulate<1|2>:UNIT:POWer AMPere
WATT	CALCulate<1|2>:UNIT:POWer WATT
RF ATTEN MANUAL	INPut:ATTenuation <num_value>
RF ATTEN AUTO	INPut:ATTenuation:AUTO ON
REF LEVEL POSITION	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:RPOSition <num_value>
REF LEVEL OFFSET	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:RLEVel:OFFSet <num_value>
GRID ABS/REL	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:Y[:SCALe]:MODE ABSolute|RELative
RF INPUT 50Ω 75Ω	INPut:IMPedance 50 | 75

MKR Key

MKR

MARKER 1 to 4

```
CALCulate<1|2>:MARKer<1 to 4>[:STATe]   ON | OFF;
CALCulate<1|2>:MARKer<1 to 4>:X <numeric value>;
CALCulate<1|2>:MARKer<1 to 4>:Y?
CALCulate<1|2>:DELTamarker1[:STATe]   ON | OFF;
CALCulate<1|2>:DELTamarker<1 to 4>:X <numeric value>;
CALCulate<1|2>:DELTamarker<1 to 4>:Y?
```

MARKER NORM DELTA

```
CALCulate<1|2>:DELTamarker<1 to 4>[:STATe]   ON | OFF;
```

SIGNAL COUNT

```
CALCulate<1|2>:MARKer<1 to 4>:COUNt   ON | OFF;
CALCulate<1|2>:MARKer<1 to 4>:COUNt:FREQuency?
```

REFERENCE FIXED

REF FXD FREQUENCY

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed[:STATe]  ON | OFF
```

REF POINT LEVEL

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y <num_value>
```

REF POINT LVL OFFSET

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y:OFFSet
<num_value>
```

REF POINT FREQUENCY

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:X  <num_value>
```

or:

REF POINT TIME

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:X  <num_value>
```

MARKER ZOOM

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:ZOOM <num_value>
```

ALL MARKER OFF

```
CALCulate<1|2>:MARKer<1 to 4>:AOFF
CALCulate<1|2>:DELTamarker<1 to 4>:AOFF
```

MKR-> TRACE

```
CALCulate<1|2>:MARKer<1 to 4>:TRACe <num_value>
CALCulate<1|2>:DELTamarker<1 to 4>:TRACe <num_value>
```

NOISE MEAS

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NOISe[:STATe] ON | OFF;
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NOISe:RESult?
```

CNT RESOL ...

```
CALCulate<1|2>:MARKer<1 to 4>:COUNt:RESolution <numeric value>
```

MKR-> Key

MKR->	
SELECT MARKER	No corresponding IEC/IEEE-bus command
PEAK	CALCulate<1|2>:MARKer<1 to 4>:MAXimum[:PEAK] CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum[:PEAK]
CENTER = MKR FREQ	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:CENTer
REF LEVEL = MKR LVL	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:REFerence
NEXT PEAK	CALCulate<1|2>:MARKer<1 to 4>:MAXimum:NEXT CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:NEXT
NEXT MODE	
ABSOLUTE PEAK / MIN	CALCulate<1|2>:MARKer<1 to 4>:MAXimum:NEXT CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:NEXT CALCulate<1|2>:MARKer<1 to 4>:MINimum:NEXT CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:NEXT
SEARCH NEXT LEFT	CALCulate<1|2>:MARKer<1 to 4>:MAXimum:LEFT CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:LEFT CALCulate<1|2>:MARKer<1 to 4>:MINimum:LEFT CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:LEFT
SEARCH NEXT RIGHT	CALCulate<1|2>:MARKer<1 to 4>:MAXimum:RIGHt CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum:RIGHt CALCulate<1|2>:MARKer<1 to 4>:MINimum:RIGHt CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:RIGHt
SEARCH LIMITS	
LEFT LIMIT	CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits[STATe] ON | OFF CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits:LEFT <num_value>
RIGHT LIMIT	CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits[STATe] ON | OFF CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits:RIGHt <num_value>
THRESHOLD	CALCulate<1|2>:THReshold[STATe] ON | OFF CALCulate<1|2>:THReshold <num_value>
SEARCH LIM OFF	CALCulate<1|2>:MARKer<1 to 4>:X:SLIMits[STATe] OFF
PEAK EXCURSION	CALCulate<1|2>:MARKer<1 to 4>:PEXCursion <num_value>
MKR-> TRACE	CALCulate<1|2>:MARKer<1 to 4>:TRACe <numeric value> CALCulate<1|2>:DELTamarker<1 to 4>:TRACe <numeric value>
MKR-> CF STEPSIZE	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:CSTep
MIN	CALCulate<1|2>:MARKer<1 to 4>:MINimum[:PEAK] CALCulate<1|2>:DELTamarker<1 to 4>:MINimum[:PEAK]
MIN NEXT	CALCulate<1|2>:MARKer<1 to 4>:MINimum:NEXT CALCulate<1|2>:DELTamarker<1 to 4>:MINimum:NEXT
NEXT MODE	See above
EXCLUDE LO	CALCulate<1|2>:MARKer<1 to 4>:LOEXclude ON | OFF

MKR FCTN Key

MKR FUNC

SELECT MARKER

no corresponding IEC/IEEE-bus command

PEAK

```
CALCulate<1|2>:MARKer<1 to 4>:MAXimum[:PEAK]
CALCulate<1|2>:DELTamarker<1 to 4>:MAXimum[:PEAK]
```

PHASE NOISE

PH NOISE ON OFF

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:PNOise[:STATe]  ON | OFF
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:PNOise:RESult?
```

REF POINT LEVEL

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y <num_value>
```

REF POINT LVL OFFSET

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:Y:OFFSet
<num_value>
```

REF POINT FREQUENCY

```
CALCulate<1|2>:DELTamarker<1 to 4>:FUNCtion:FIXed:RPOint:X  <num_value>
```

MODULATION DEPTH

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:MDEPth[:STATe]  ON | OFF
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:MDEPth:RESult?
```

TOI

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:TOI[:STATe]  ON | OFF
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:TOI:RESult?
```

N dB DOWN

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown[:STATe] ON | OFF
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown <num_value>
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown:RESult?
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:NDBDown:FREQuency
```

MARKER DEMOD

with option audio demodulator FSP-B3 only

MKR DEMOD ON/OFF

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:DEModulation[:STATe]  ON | OFF
```

AM

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:DEModulation:SELect  AM
```

FM

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:DEModulation:SELect  FM
```

MKR STOP TIME

```
CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:DEModulation:HOLDoff <num_value>
```

MKR-> TRACE

```
CALCulate<1|2>:MARKer<1 to 4>:TRACe <numeric value>
CALCulate<1|2>:DELTamarker<1 to 4>:TRACe <numeric value>
```

BW Key

BW	
RES BW MANUAL	[SENSe:]BANDwidth|BWIDth:AUTO OFF [SENSe:]BANDwidth|BWIDth[:RESolution] <num_value>
VIDEO BW MANUAL	[SENSe:]BANDwidth|BWIDth:VIDeo:AUTO OFF [SENSe:]BANDwidth|BWIDth:VIDeo <num_value>
SWEEP TIME MANUAL	[SENSe:]SWEep:TIME:AUTO OFF [SENSe:]SWEep:TIME <num_value>
RES BW AUTO	[SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO ON
VIDEO BW AUTO	[SENSe:]BANDwidth|BWIDth:VIDeo:AUTO ON
SWEEP TIME AUTO	[SENSe:]SWEep:TIME:AUTO ON
COUPLING RATIO	--
RBW / VBW SINE [1/3]	[SENSe:]BANDwidth|BWIDth:VIDeo:RATio 3
RBW / VBW PULSE [.1]	[SENSe:]BANDwidth|BWIDth:VIDeo:RATio 10
RBW / VBW NOISE [10]	[SENSe:]BANDwidth|BWIDth:VIDeo:RATio 0.1
RBW / VBW MANUAL	[SENSe:]BANDwidth|BWIDth:VIDeo:RATio <num_value>
SPAN / RBW AUTO [50]	[SENSe:]BANDwidth|BWIDth[:RESolution]:RATio 0.02
SPAN / RBW MANUAL	[SENSe:]BANDwidth|BWIDth[:RESolution]:RATio <num_value>
COUPLING DEFAULT	[SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO ON; [SENSe:]BANDwidth|BWIDth:VIDeo:AUTO ON; [SENSe:]SWEep:TIME:AUTO ON
FILTER FFT NORMAL	[SENSe:]BANDwidth|BWIDth[:RESolution]:MODE:FFT ON | OFF

SWEEP Key

SWEEP	
CONTINUOUS SWEEP	INITiate:CONTinuous ON
SINGLE SWEEP	INITiate:CONTinuous OFF; INITiate:IMMediate
CONTINUE SGL SWEEP	INITiate:CONMeasure
SWEEP TIME MANUAL	[SENSe:]SWEep:TIME <num_value>
SWEEP TIME AUTO	[SENSe:]SWEep:TIME:AUTO ON | OFF
SWEEP COUNT	[SENSe:]SWEep:COUNt <num_value>
SGL SWEEP DISP OFF	INITiate:DISPlay OFF INITiate:IMMediate

MEAS Key

MEAS	
TIME DOM POWER	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS[:STATe] ON CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak[:STATe] ON CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN[:STATe] ON CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation[:STATe] ON
POWER ON OFF	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS[:STATe] ON|OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak[:STATe] ON|OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN[:STATe] ON|OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation[:STATe] ON|OFF
RMS	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS[:STATe] ON | OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS:RESult?
PEAK	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak[:STATe] ON | OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak:RESult?
MEAN	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN[:STATe] ON | OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MEAN:RESult?
STANDARD DEVIATION	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation[:STATe] ON|OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation:RESult?
LIMITS ON OFF	CALCulate<1|2>:MARKer<1 to 4>:SLIMits ON | OFF
START LIMIT	CALCulate<1|2>:MARKer<1 to 4>:SLIMits:LEFT <num_value>
STOP LIMIT	CALCulate<1|2>:MARKer<1 to 4>:SLIMits:RIGHt <num_value>
SET REFERENCE	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:REFerence:AUTO ONCE
POWER ABS REL	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:MODE ABS | REL
MAX HOLD ON OFF	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PHOLd ON | OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak:PHOLd:RESult? CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS:PHOLd:RESult? CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMar:MEAN:PHOLd:RESult? CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?
AVERAGE ON OFF	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:AVERage ON | OFF CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:PPEak:AVERage:RESult? CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:RMS:AVERage:RESult? CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMar:MEAN:AVERage:RESult? CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:SUMMary:SDEViation:AVERage:RES?
NUMBER OF SWEEPS	[SENSe:]SWEep:COUNt <num_value>
CHAN PWR ACP	--
CP / ACP ON OFF	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:SELect CPOWer | ACPower; CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:RESult? CPOWer | ACPower; CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer[:STATe] OFF
CP / ACP STANDARD	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:PRESet <standard>
CP / ACP CONFIG	--
NO. OF ADJ CHAN	[SENSe:]POWer:ACHannel:ACPairs <num_value>
CHANNEL BANDWIDTH	[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel] <num_value>

ADJ CHAN BANDWIDTH	[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel <num_value> [SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<1|2> <num_value>
ADJ CHAN SPACING	[SENSe:]POWer:ACHannel:SPACing:ACHannel <num_value> [SENSe:]POWer:ACHannel:SPACing:ALTernate<1|2> <num_value>
CP/ACP ABS/REL	[SENSe:]POWer:ACHannel:MODE ABSolute|RELative
FAST ACP ON OFF	[SENSe:]POWer:HSPeed ON | OFF
SELECT TRACE	[SENSe:]POWer:TRACe 1|2|3
ADJUST REF LVL	[SENSe:]POWer:ACHannel:PRESet:RLEVel
ADJUST SETTINGS	[SENSe:]POWer:ACHannel:PRESet ACPower|CPOWer|OBANdwidth|OBWidth
ACP LIMIT CHECK	CALCulate<1|2>:LIMit<1 to 8>:ACPower[:STATe] ON | OFF CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:RESult? CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate<1|2>:RESult?
EDIT ACP LIMITS	CALCulate<1|2>:LIMit<1 to 8>:ACPower[:STATe] ON | OFF CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel[:RELative]:STATe ON | OFF CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel[:RELative] <num_val>,<num_val> CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:ABSolute:STATe ON | OFF CALCulate<1|2>:LIMit<1 to 8>:ACPower:ACHannel:ABSolute <num_value>,<num_value> CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate[:RELative]:STATe ON | OFF CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate[:RELative] <num_value>,<num_value> CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate:ABSolute:STATe ON | OFF CALCulate<1|2>:LIMit<1 to 8>:ACPower:ALTernate:ABSolute <num_value>,<num_value>
SET CP REFERENCE	[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE
CHAN PWR /HZ	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:RESult:PHZ ON | OFF
NOISE CORR ON OFF	[SENSe:]POWer:NCORrection ON | OFF
SWEEP TIME	[SENSe:]SWEep:TIME <num_value>
ADJUST REF LVL	[SENSe:]POWer:ACHannel:PRESet:RLEVel
ADJUST SETTINGS	[SENSe:]POWer:ACHannel:PRESet ACPower|CPOWer|OBANdwidth|OBWidth
OCCUPIED PWR BANDW	
OCCUP BW ON OFF	CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:SELect OBANdwidth |OBWidth CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer:RESult? OBANdwidth|OBWidth CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:POWer[:STATe] OFF
% POWER BANDWIDTH	[SENSe:]POWer:BANDwidth|BWIDth <num_value>
CHANNEL BANDWIDTH	[SENSe:]POWer:ACHannel:BANDwidth|BWIDth <num_value>
NOISE CORR ON OFF	[SENSe:]POWer:NCORrection ON | OFF
ADJUST REF LVL	[SENSe:]POWer:ACHannel:PRESet:RLEVel
ADJUST SETTINGS	[SENSe:]POWer:PRESet ACPower|CPOWer|OBANdwidth|OBWidth

SIGNAL STATISTIC	
APD ON OFF	CALCulate:STATistics:APD[:STATe] ON | OFF CALCulate:STATistics:RESult<1 to 3>? MEAN | PEAK | CFACtor | ALL
CCDF ON OFF	CALCulate:STATistics:CCDF[:STATe] ON | OFF CALCulate:STATistics:RESult<1 to 3>? MEAN | PEAK | CFACtor | ALL
RES BW	[SENSe:]BANDwidth[:RESolution]:AUTO OFF [SENSe:]BANDwidth[:RESolution] <num_value>
NO OF SAMPLES	CALCulate:STATistics:NSAMples <num_value>
SCALING	--
X-AXIS REF LEVEL	CALCulate:STATistics:X:RLEVel <num_value>
X-AXIS RANGE	CALCulate:STATistics:X:RANGe <num_value>
Y-AXIS MAX VALUE	CALCulate:STATistics:Y:UPPER <num_value>
Y-AXIS MIN VALUE	CALCulate:STATistics:Y:LOWer <num_value>
ADJUST SETTINGS	CALCulate:STATistics:SCALe:AUTO ONCE
DEFAULT SETTINGS	CALCulate:STATistics:PRESet
ADJUST SETTINGS	CALCulate:STATistics:SCALe:AUTO ONCE
SINGLE MEAS	INITiate:CONTinuous OFF; INITiate:IMMediate
COUNT MEAS	INITiate:CONTinuous ON; INITiate:IMMediate

TRIG Key

TRIG	
FREE RUN	TRIGger[:SEQuence]:SOURce IMMediate
VIDEO	TRIGger[:SEQuence]:SOURce VIDeo TRIGger[:SEQuence]:LEVel:VIDeo <numeric value>
EXTERN	TRIGger[:SEQuence]:SOURce EXTernal [SENSe:]SWEep:EGATe:SOURce EXTernal
IF POWER	TRIGger[:SEQuence]:SOURce IFPower [SENSe:]SWEep:EGATe:SOURce IFPower
TRIGGER OFFSET	TRIGger[:SEQuence]:HOLDoff <num_value>
POLARITY POS/NEG	TRIGger[:SEQuence]:SLOPe POSitive | NEGative or [SENSe:]SWEep:EGATe:POLarity POSitive | NEGative
GATED TRIGGER	[SENSe:]SWEep:EGATe ON | OFF [SENSe:]SWEep:EGATe:SOURce IFPower | EXTernal
GATE SETTINGS	--
GATE MODE LEVEL/EDGE	[SENSe:]SWEep:EGATe:TYPE LEVel | EDGE
POLARITY POS/NEG	[SENSe:]SWEep:EGATe:POLarity POSitive | NEGative
GATE DELAY	[SENSe:]SWEep:EGATe:HOLDoff <num_value>
GATE LENGTH	[SENSe:]SWEep:EGATe:LENGth <num_value>
ZOOM X-AXIS	--

TRACE Key

TRACE	
SELECT TRACE	--
CLEAR/ WRITE	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:MODE WRITe
MAX HOLD	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:MODE MAXHold
AVERAGE	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:MODE AVERage or: [SENSe:]AVERage[:STATe<1 to 3>] ON
VIEW	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:MODE VIEW
BLANK	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>[:STATe] OFF
SWEEP COUNT	[SENSe:]SWEep:COUNt <num_value> or: [SENSe:]AVERage:COUNt <num_value>
DETECTOR	--
AUTO SELECT	[SENSe:]DETector[:FUNCtion]:AUTO ON | OFF
DETECTOR AUTOPEAK	[SENSe:]DETector[:FUNCtion] APEak
DETECTOR MAX PEAK	[SENSe:]DETector[:FUNCtion] POSitive
DETECTOR MIN PEAK	[SENSe:]DETector[:FUNCtion] NEGative
DETECTOR SAMPLE	[SENSe:]DETector[:FUNCtion] SAMPle
DETECTOR RMS	[SENSe:]DETector[:FUNCtion] RMS
DETECTOR AVERAGE	[SENSe:]DETector[:FUNCtion] AVERage
DETECTOR QPK	[SENSe:]DETector[:FUNCtion] QPEak
TRACE MATH	--
T1-T2->T1	CALCulate<1|2>:MATH:STATe ON CALCulate<1|2>:MATH[:EXPRession][:DEFine] (TRACE1 - TRACE2)
T1-T3->T1	CALCulate<1|2>:MATH:STATe ON CALCulate<1|2>:MATH[:EXPRession][:DEFine] (TRACE1 - TRACE3)
TRACE POSITION	CALCulate<1|2>:MATH:POSition <num_value>
TRACE MATH OFF	CALCulate<1|2>:MATH:STATe OFF

MIN HOLD	DISPlay[:WINDow<1|2>]:TRACe<1 to 3>:MODE MINHold
AVG MODE LOG LIN	CALCulate<1|2>:MATH:MODE LINear | LOGarithmic or: [SENSe:]AVERage:TYPE VIDeo | LINear
ASCII FILE EXPORT	FORMat[:DATA] ASCii MMEMory:STORe<1|2>:TRACe 1,'TRACE.DAT'
DECIM SEP . ,	FORMat:DEXPort:DSEParator POINt | COMMa
COPY TRACE	TRACe:COPY TRACE1|TRACE2|TRACE3,TRACE1|TRACE2|TRACE3

LINES Key

LINES

SELECT LIMIT LINE

selection:
```
CALCulate<1|2>:LIMit<1 to 8>:NAME <string>;
CALCulate<1|2>:LIMit<1 to 8>:UPPer:STATe   ON | OFF
CALCulate<1|2>:LIMit<1 to 8>:LOWer:STATe ON | OFF
```
limit check:
```
CALCulate<1|2>:LIMit<1 to 8>:STATe ON | OFF
INITiate[:IMMediate]; WAI*
CALCulate<1|2>:LIMit<1 to 8>:FAIL?
```
trace assignment:
```
CALCulate<1|2>:LIMit<1 to 8>:TRACe 1|2|3
```

NEW LIMIT LINE

NAME

name:
```
CALCulate<1|2>:LIMit<1 to 8>:NAME <string>;
```
domain:
```
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:DOMain   FREQuency|TIME
```
scaling:
```
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:MODE   RELative | ABSolute
CALCulate<1|2>:LIMit<1 to 8>:UPPer:MODE   RELative | ABSolute
CALCulate<1|2>:LIMit<1 to 8>:LOWer:MODE   RELative | ABSolute
```
unit:
```
CALCulate<1|2>:LIMit<1 to 8>:UNIT   DBM| DBPW| WATT| DBUV|
VOLT|DBUA|AMPere| DB| DBUV_MHZ| DBUA_MHZ| DEG| RAD| S| HZ| PCT
```
margin:
```
CALCulate<1|2>:LIMit<1 to 8>:UPPer:MARGin <num_value>
CALCulate<1|2>:LIMit<1 to 8>:LOWer:MARGin <num_value>
```
threshold for relative y-scaling:
```
CALCulate<1|2>:LIMit<1 to 8>:UPPer:THReshold <num_value>
CALCulate<1|2>:LIMit<1 to 8>:LOWer:THReshold <num_value>
```
comment:
```
CALCulate<1|2>:LIMit<1 to 8>:COMMent <string>
```

VALUES

```
CALCulate<1|2>:LIMit<1 to 8>:CONTrol[:DATA] <num_value>, <num_value>..
CALCulate<1|2>:LIMit<1 to 8>:UPPer[:DATA] <num_value>, <num_value>..
CALCulate<1|2>:LIMit<1 to 8>:LOWer[:DATA] <num_value>,<num_value>..
```

INSERT VALUE

no corresponding IEC/IEEE-bus command

DELETE VALUE

no corresponding IEC/IEEE-bus command

SHIFT X LIMIT LINE

```
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:SHIFt <num_value>
```

SHIFT Y LIMIT LINE

```
CALCulate<1|2>:LIMit<1 to 8>:UPPer:SHIFt <num_value>
CALCulate<1|2>:LIMit<1 to 8>:LOWer:SHIFt <num_value>
```

SAVE LIMIT LINE

automatically executed during IEC/IEEE-bus operation

EDIT LIMIT LINE

```
s. EDIT LIMIT LINE
```

COPY LIMIT LINE

```
CALCulate<1|2>:LIMit<1 to 8>:COPY 1 to 8 | <name>
```

DELETE LIMIT LINE

```
CALCulate<1|2>:LIMit<1 to 8>:DELete
```

X OFFSET

```
CALCulate<1|2>:LIMit<1 to 8>:CONTrol:OFFset <num_value>
```

Y OFFSET

```
CALCulate<1|2>:LIMit<1 to 8>:UPPer:OFFset <num_value>
CALCulate<1|2>:LIMit<1 to 8>:LOWer:OFFset <num_value>
```

DISP Key

DISP	
FULL SCREEN	DISPlay:FORmat SINGle DISPlay[:WINDow<1|2>]:SELect
SPLIT SCREEN	DISPlay:FORmat SPLit
REF LEVEL COUPLED	INSTrument:COUPle RLEVel | NONE
CENTER B = MARKER A	INSTrument:COUPle CF_B | NONE
CENTER A = MARKER B	INSTrument:COUPle CF_A | NONE
CONFIG DISPLAY	--
SCREEN TITLE	DISPlay[:WINDow<1|2>]:TEXT[:DATA] <string> DISPlay[:WINDow<1|2>]:TEXT:STATe ON | OFF
TIME/DATE ON OFF	DISPlay[:WINDow<1|2>]:TIME ON | OFF
LOGO ON/OFF	DISPlay:LOGO ON|OFF
ANNOTATION ON/OFF	DISPlay:ANNotation:FREQuency ON|OFF
DATAENTRY OPAQUE	no corresponding IEC/IEEE-bus command
DEFAULT COLORS 1	DISPlay:CMAP<1 to 13>:DEFault1
DEFAULT COLORS 2	DISPlay:CMAP<1 to 13>:DEFault2
DISPLAY PWR SAVE	DISPlay:PSAVe[:STATe] ON | OFF DISPlay:PSAVe:HOLDoff <num_value>
SELECT OBJECT	--
BRIGHTNESS	DISPlay:CMAP:HSL <hue>,<sat>,<lum>
TINT	DISPlay:CMAP<1 to 13>:HSL <hue>,<sat>,<lum>
SATURATION	DISPlay:CMAP<1 to 13>:HSL <hue>,<sat>,<lum>
PREDEFINED COLORS	DISPlay:CMAP<1 to 13>:PDEFined BLACk| BLUE| BROWn| GREen| CYAN| RED| MAGenta| YELLow| WHITe| DGRAy| LGRAy| LBLUe| LGREen| LCYan| LRED| MAGenta

FILE Key

FILE	
SAVE	MMEMory:STORe:STATe 1,<file_name>
RECALL	MMEMory:LOAD:STATe 1,<file_name>
EDIT COMMENT	MMEMory:COMMent <string>
ITEMS TO SAVE/RCL	
SELECT ITEMS	MMEMory:SELect[:ITEM]:HWSettings ON|OFF MMEMory:SELect[:ITEM]:TRACe[:ACTive] ON|OFF MMEMory:SELect[:ITEM]:LINes:ALL ON|OFF MMEMory:SELect[:ITEM]:NONE
DEFAULT CONFIG	MMEMory:SELect[:ITEM]:DEFault
DISABLE ALL ITEMS	MMEMory:SELect[:ITEM]:NONE
ENABLE ALL ITEMS	MMEMory:SELect[:ITEM]:ALL
DATA SET LIST	--
DATA SET CLEAR	MMEMory:CLEar:STATe 1,<file_name>
DATA SET CLEAR ALL	MMEMory:CLEar:ALL
STARTUP RECALL	MMEMory:LOAD:AUTO 1,<file_name>
FILE MANAGER	
EDIT PATH	MMEMory:MSIS <device> MMEMory:CDIRectory <directory_name>
MAKE DIRECTORY	MMEMory:MDIRectory <directory_name>
FORMAT DISK	MMEMory:INITialize <msus>
RENAME	MMEMory:MOVE <file_source>,<file_destination>
SORT MODE	no corresponding IEC/IEEE-bus command
COPY	MMEMory:COPY <file_source>,<file_destination>
DELETE	MMEMory:DELete <file_name> MMEMory:RDIRectory <directory_name>

CAL Key

CAL	
CAL TOTAL	CALibration[:ALL]?
CAL ABORT	CALibration:ABORt
CAL CORR ON OFF	CALibration:STATe ON | OFF
CAL RESULTS	CALibration:RESults?

SETUP Key

REFERENCE INT/EXT	[SENSe:]ROSCillator:SOURce INTernal|EXTernal
NOISE SCR ON OFF	DIAGnostic:SERVice:NSOurce ON | OFF <num_value>
GENERAL SETUP	--
GPIB ADDRESS	SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 0 to 30
COM INTERFACE	SYSTem:COMMunicate:SERial[:RECeive:]BAUD <num_value> SYSTem:COMMunicate:SERial[:RECeive]:BITS 7 | 8 SYSTem:COMMunicate:SERial:RECeive:PARity[:TYPE] EVEN | ODD | NONE SYSTem:COMMunicate:SERial[:RECeive]:SBITs 1|2 SYSTem:COMMunicate:SERial:CONTrol:DTR IBFull | OFF SYSTem:COMMunicate:SERial:CONTrol:RTS IBFull | OFF SYSTem:COMMunicate:SERial[:RECeive]:PACE XON | NONE
TIME+DATE	SYSTem:TIME 0 to 23, 0 to 59, 0 to 59 SYSTem:DATE <num>,<num>,<num>
SYSTEM INFO	--
HARDWARE INFO	--
STATISTICS	--
SYSTEM MESSAGES	SYSTem:ERRor?
CLEAR ALL MESSAGES	SYSTem:ERRor?
SAVE CHANGES	--
SERVICE	--
INPUT RF	DIAGnostic:SERVice:INPut[:SELect] RF
INPUT CAL	DIAGnostic:SERVice:INPut[:SELect] CALibration DIAGnostic:SERVice:CSOurce[:POWer] <num_value>
SELFTEST	*TST?
SELFTEST RESULTS	DIAGnostic:SERVice:STEst:RESult?
REFERENCE FREQUENCY	[SENSE<1|2>:]ROSCillator[:INTernal]:TUNe 0 to 4095
CAL SIGNAL POWER	--
SAVE CHANGES	[SENSE<1|2>:]ROSCillator[:INTernal]:TUNe:SAVe
ENTER PASSWORD	SYSTem:PASSword[:CENable] <string>
SERVICE FUNCTION	DIAGnostic:SERVice:SFUNction <string>
FIRMWARE UPDATE	--
RESTORE FIRMWARE	--

HCOPY Key

HCOPY

PRINT SCREEN

```
HCOPy:ITEM:ALL
HCOPy:IMMediate
```

for printout into file add `MMEMory:NAME <file_name>`

PRINT TRACE

```
HCOPy:ITEM:WINDow<1|2>:TRACe:STATe   ON | OFF
HCOPy:IMMediate
```

for printout into file add `MMEMory:NAME <file_name>`

PRINT TABLE

```
HCOPy:ITEM:WINDow<1|2>:TABle:STATe   ON | OFF
HCOPy:IMMediate
```

for printout into file add `MMEMory:NAME <file_name>`

HARDCOPY ABORT

```
HCOPy:ABORt
```

DEVICE1

```
SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?
SYSTem:COMMunicate:PRINter:ENUMerate:NEXT?
SYSTem:COMMunicate:PRINter:SELect <string>
HCOPy:DESTination   <string>
HCOPy:DEVice:LANGuage   GDI | WMF | EWMF | BMP
HCOPy:PAGE:ORIentation<1|2>   LANDscape | PORTrait
```

DEVICE2

```
SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?
SYSTem:COMMunicate:PRINter:ENUMerate:NEXT?
SYSTem:COMMunicate:PRINter:SELect "string>
HCOPy:DESTination2   <string>
HCOPy:DEVice:LANGuage   GDI | WMF | EWMF | BMP
HCOPy:PAGE:ORIentation<1|2>   LANDscape | PORTrait
```

COLOR ON/OFF

```
HCOPy:DEVice:COLor ON | OFF
```

COMMENT SCREEN A/B

```
HCOPy:ITEM:WINDow<1|2>:TEXT   <string>
```

Hotkeys

SPECTRUM

```
INSTrument[:SELect] SANalyzer
INSTrument:NSELect 1
```

SCREEN A/B

FULL SCREEN: Selection of the active window: `DISPlay[:WINDow<1|2>]:SELect`
The window valid for the setting is selected by the numeric suffix in the command, eg `SENSe<1|2>`

SPLIT SCREEN: The two measurement windows are active.
The window valid for the setting is selected by the numeric suffix in the command, eg `SENSe<1|2>`

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7 Remote Control - Programming Examples

The following programming examples have a hierarchical structure, ie subsequent examples are based on previous ones. It is thus possible to compile very easily an operational program from the modules of the given examples.

Basic Steps of IEC/IEEE-Bus Programming

The examples explain the programming of the instrument and can serve as a basis to solve more complex programming tasks.

VISUAL BASIC has been used as programming language. However, the programs can be translated into other languages.

Including IEC-Bus Library for VisualBasic

Programming hints:

- **Output of texts using the "Print" function**

  The following programming examples are based on the assumption that all subroutines are part of a form (file extension: .FRM). In this case the syntax

  ```
  Print "Text"
  ```

  is permissible.

  If however the subroutines are stored as a so-called module (file extension: .BAS), the print instruction should be preceded by the name of a form which has the required print method. If, for example, there is a form with the name "Main", the associated print instruction is as follows:

  ```
  Main.Print "Text".
  ```

- **Access to funtions of GPIB.DLL**

  To create Visual Basic control applications the file GPIB.BAS (as from VB 6.0 VBIB-32.BAS) is added to a project so that the functions of the RSIB.DLL can be called. In addition, the file NIGLOBAL.BAS is added to the project. This file contains constants and definitions for the processing of errors, timeout values, etc.

- **Declaration of DLL functions as procedures**

  Since the functions all return an integer value, the functions in the file GPIB.BAS are all declared as follows:

  ```
  Declare Function xxx Lib "gpib.dll" ( ... ) As Integer
  ```

  The function value with the status variables `ibsta` should be allocated a variable when it is called up. Since this value is also returned via a reference parameter of the functions, the functions can be declared as procedures as follows:

  ```
  Declare Sub xxx Lib "rsib.dll" ( ... )
  ```

- **Generating a response buffer**

  Since the DLL returns zero-terminated strings in case of responses, a string of sufficient length should be generated prior to calling the functions `ibrd()` and `ilrd()`, since Visual Basic prefixes a length value to the strings which is not updated by the DLL.
  The following two possibilities are available to generate a length value for a string:

  - **`Dim Rd as String * 100`**
  - **`Dim Rd as String`**
    `Rd = Space$(100)`

Initialization and Default Status

Variables used by all subroutines should be stored at the beginning of every program.
Then the IEC/IEEE bus as well as the settings of the instrument are brought into a defined default status at the beginning of every program. Subroutines `"InitController"` and `"InitDevice"` are used to this effect.

Creating global variables

Global variables are placed in so-called "modules" (file extension: .BAS) in Visual Basic. Therefore, at least one module (z.B. "GLOBALS.BAS) should be created which contains the variables used by all subroutines, such as the device addresses used by the IEC/IEEE-bus driver.
The file should contain the following instructions for the programming examples below:

```
Global analyzer As Integer
Global boardId As Integer
```

Initiate Controller

```
REM ------------ Initiate controller ---------------------------------------
Public SUB InitController()

iecaddress% = 20                          'IEC/IEEE-bus address of the
                                          'instrument
CALL IBFIND("GPIB0", boardId%)            'Open port to the controller
CALL IBFIND("DEV1", analyzer%)            'Open port to the instrument
CALL IBPAD(analyzer%, iecaddress%)        'Inform controller on instrument
                                          'address
CALL IBTMO(analyzer%, 11)                 'Response time to 1 sec
END SUB
REM ************************************************************************
```

Initiate Instrument

The IEC-bus status registers and instrument settings of the instrument are brought into the default status.

```
REM ------------ Initiate instrument -----------------------------------
Public SUB InitDevice()

CALL IBWRT(analyzer%, "*CLS")           'Reset status registers
CALL IBWRT(analyzer%, "*RST")           'Reset instrument
END SUB
REM***************************************************************************
```

Configuring Power Save Function of Display

The results on the screen are often not required during IEC/IEEE-bus operation. Although the command "SYSTem:DISPlay:UPDate OFF" switches off the display of results which brings considerable advantages in terms of speed in the remote control mode, the display itself and in particular the backlighting remain switched on.

If required, the display should be switched off by means of the power-save function, the response time having to be set in minutes prior to activation.

Note: *The display is switched on as soon as a key is pressed on the instrument front panel.*

```
REM --------- Configure power save function -------------------------------
Public SUB PowerSave()

CALL IBWRT(analyzer%, "SYSTem:PSAVe:HOLDoff 1") 'Set holdoff to 1 minute
CALL IBWRT(analyzer%, "SYSTem:PSAVe ON")        'Power save function on
END SUB
REM***************************************************************************
```

Transmission of Simple Instrument Setting Commands

Center frequency, span, and reference level of the instrument are set in this example.

```
REM -------- Instrument setting commands ---------------------------------
PUBLIC SUB SimpleSettings()

CALL IBWRT(analyzer%, "FREQUENCY:CENTER 128MHz")  'Center frequency 128 MHz
CALL IBWRT(analyzer%, "FREQUENCY:SPAN 10MHZ")     'Span 10 MHz
CALL IBWRT(analyzer%, "DISPLAY:TRACE:Y:RLEVEL -10dBm")
                                                  'Reference level -10dBm
END SUB
REM ***************************************************************************
```

Switchover to Manual Control

```
REM -------- Switch instrument over to manual control --------------------
CALL IBLOC(analyzer%)                  'Set instrument to Local state
REM ***************************************************************************
```

Reading out Instrument Settings

The settings made in the above example are read out here. The abbreviated commands are used.

```
REM --------- Reading out instrument settings ----------------------------
PUBLIC SUB ReadSettings()

CFfrequency$ = SPACE$(20)              'Provide text variables (20 characters)
CALL IBWRT(analyzer%, "FREQ:CENT?")    'Request center frequency
CALL IBRD(analyzer%, CFfrequency$)     'Read value

CFspan$ = SPACE$(20)                   'Provide text variables (20 characters)
CALL IBWRT(analyzer%, "FREQ:SPAN?")    'Query span
CALL IBRD(analyzer%, CFspan$)          'Read value

RLevel$ = SPACE$(20)                   'Provide text variables (20 characters)
CALL IBWRT(analyzer%, "DISP:TRAC:Y:RLEV?")
                                       'Query reference level
CALL IBRD(analyzer%, RLevel$)          'Read value
```

```
REM --------------- Display values on the screen ------------------------
PRINT "Center frequency: "; CFfrequency$,
PRINT "Span:             "; CFspan$,
PRINT "Reference level:  "; RLevel$,
REM*************************************************************************
```

Positioning a Marker and Displaying Values

```
REM -------------- Examples of marker functions ---------------------------
PUBLIC SUB ReadMarker()

CALL IBWRT(analyzer%, "CALC:MARKER ON;MARKER:MAX")
            'Activate marker1 and start peak search
MKmark$ = SPACE$(30)              'Provide text variables (30 characters)
CALL IBWRT(analyzer%, "CALC:MARK:X?;Y?")     'Query frequency and level
CALL IBRD(analyzer%, MKmark$)                'Read value

REM -------------- Display values on the screen -------------------------
PRINT "Center frequency / level "; MKmark$,
REM *************************************************************************
```

Command synchronization

The possibilities for synchronization implemented in the following example are described in Chapter 5, Section "Command Order and Command Synchronization".

```
REM -------- Examples of command synchronization -------------------------
PUBLIC SUB SweepSync()


REM The command INITiate[:IMMediate] starts a single sweep if the command
REM INIT:CONT OFF was previously sent. It should be ensured that the next
REM command is only then executed when the entire sweep is complete.
CALL IBWRT(analyzer%, "INIT:CONT OFF")

REM -------- First possibility: Use of *WAI ------------------------------
CALL IBWRT(analyzer%, "ABOR;INIT:IMM; *WAI")

REM -------- Second possibility: Use of *OPC? ----------------------------
OpcOk$ = SPACE$(2)                    'Space for *OPC? - Provide response
CALL IBWRT(analyzer%, "ABOR;INIT:IMM; *OPC?")
REM -------- here the controller can service other instrument-------------
CALL IBRD(analyzer%, OpcOk$)                    'Wait for "1" from *OPC?

REM -------- Third possibility: Use of *OPC ------------------------------
REM In order to be able touse the service request function in conjugation
REM with a National Instruments GPIB driver, the setting "Disable
REM Auto Serial Poll" must be changed to "yes" by means of IBCONF!
CALL IBWRT(analyzer%, "*SRE 32")      'Permit service request for ESR
CALL IBWRT(analyzer%, "*ESE 1")       'Set event-enable bit for
                                      'operation-complete bit
CALL IBWRT(analyzer%, "ABOR;INIT:IMM; *OPC") 'Start sweep and
                                             'synchronize with OPC
CALL WaitSRQ(boardID%,result%)        'Wait for service request
REM Continue main program here.
END SUB
REM ***************************************************************************
```

Service Request

The service request routine requires an extended initialization of the instrument in which the respective bits of the transition and enable registers are set.
In order to use the service request function in conjugation with National Instruments GPIB driver, the setting "Disable Auto Serial Poll" must be changed to "yes" by means of IBCONF.

Initiate Service Request

```
REM ---- Example of initialization of the SRQ in the case of errors --------
PUBLIC SUB SetupSRQ()


CALL IBWRT(analyzer%, "*CLS")                    'Reset status reporting system
CALL IBWRT(analyzer%,"*SRE 168")                 'Permit service request for
                                                 'STAT:OPER,STAT:QUES and ESR
                                                 'register
CALL IBWRT(analyzer%,"*ESE 60")                  'Set event-enable bit for
                                                 'command, execution, device-
                                                 'dependent and query error
CALL IBWRT(analyzer%,"STAT:OPER:ENAB 32767")     'Set OPERation enable bit for
                                                 'all events
CALL IBWRT(analyzer%,"STAT:OPER:PTR 32767")      'Set appropriate OPERation
                                                 'Ptransition bits
CALL IBWRT(analyzer%,"STAT:QUES:ENAB 32767")     'Set questionable enable bits
                                                 'for all events
CALL IBWRT(analyzer%,"STAT:QUES:PTR 32767")      'Set appropriate questionable
                                                 'Ptransition bits
CALL WaitSRQ(boardID%,result%)                   'Wait for Service Request
IF (result% = 1) THEN CALL Srq                   'If SRQ is recognized =>
                                                 'subroutine for evaluation

END SUB
REM ***************************************************************************
```

Service request routine

A service request is then processed in the service request routine.
Note: the variables userN% and userM% must be pre-assigned usefully!

```
REM ------------ Service request routine ---------------------------------
Public SUB Srq()

ON ERROR GOTO noDevice                          'No user existing
CALL IBRSP(analyzer%, STB%)                     'Serial poll, read status byte
IF STB% > 0 THEN                                'This instrument has bits set
                                                'in the STB
     SRQFOUND% = 1
     IF (STB% AND 16)  > 0 THEN CALL Outputqueue
     IF (STB% AND 4)   > 0 THEN CALL ErrorQueueHandler
     IF (STB% AND 8)   > 0 THEN CALL Questionablestatus
     IF (STB% AND 128) > 0 THEN CALL Operationstatus
     IF (STB% AND 32)  > 0 THEN CALL Esrread
  END IF
noDevice:
END SUB                                          'End of SRQ routine
REM ************************************************************************
```

Reading out the status event registers, the output buffer and the error/event queue is effected in subroutines.

Read Out of Output Buffer

```
REM -------- Subroutine for the individual STB bits ----------------------
Public SUB Outputqueue()                        'Reading the output buffer

result$ = SPACE$(100)                           'Make space for response
CALL IBRD(analyzer%, result$)
PRINT "Contents of Output Queue : "; result$
END SUB
REM ************************************************************************
```

Read Out of Error Messages

```
REM -------- Subroutine for reading the error queue -----------------------
Public SUB ErrorQueueHandler()
ERROR$ = SPACE$(100)                    'Make space for error variable
CALL IBWRT(analyzer%, "SYSTEM:ERROR?")
CALL IBRD(analyzer%, ERROR$)
PRINT "Error Description : "; ERROR$
END SUB
REM ************************************************************************
```

Evaluation of SCPI Status Registers

```
REM ------ Subroutine for evaluating Questionable Status-Register ---------
Public SUB Questionablestatus()
Ques$ = SPACE$(20)                  'Preallocate blanks to text variable
CALL IBWRT(analyzer%, "STATus:QUEStionable:EVENt?")
CALL IBRD(analyzer%, Ques$)
PRINT "Questionable Status: "; Ques$
END SUB
REM ************************************************************************

REM ------ subroutine for evaluating Operation Status-Register ------------
Public SUB Operationstatus()
Oper$ = SPACE$(20)                  'Preallocate blanks to text variable
CALL IBWRT(analyzer%, "STATus:OPERation:EVENt?")
CALL IBRD(analyzer%, Oper$)
PRINT "Operation Status: "; Oper$
END SUB
REM ************************************************************************
```

Evaluation of Event Status Register

```
REM ------ Subroutine for evaluating the Event Status Register ------------
Public SUB Esrread()
Esr$ = SPACE$(20)              'Preallocate blanks to text variable
CALL IBWRT(analyzer%, "*ESR?")                                  'Read ESR
CALL IBRD(analyzer%, Esr$)
IF (VAL(Esr$) AND 1) > 0 THEN PRINT "Operation complete"
IF (VAL(Esr$) AND 2) > 0 THEN PRINT "Request Control"
IF (VAL(Esr$) AND 4) > 0 THEN PRINT "Query Error"
IF (VAL(Esr$) AND 8) > 0 THEN PRINT "Device dependent error"
IF (VAL(Esr$) AND 16) > 0 THEN
    PRINT "Execution Error; Program aborted"'  Output error message
    STOP                                       'Stop software
    END IF
IF (VAL(Esr$) AND 32) > 0 THEN
    PRINT "Command Error; Program aborted"'    Output error message
    STOP                                       'Stop software
    END IF
IF (VAL(Esr$) AND 64) > 0 THEN PRINT "User request"
IF (VAL(Esr$) AND 128) > 0 THEN PRINT "Power on"
END SUB
REM ************************************************************************
```

More Complex Programming Examples

Basic settings of the Analyzer

The following settings are an example of how to modify the default setting of FSP.
It should be noted that only some settings are necessary depending on the example of application. In particular, the settings for resolution bandwidth, video bandwidth and sweep time are often not needed since these parameters are automatically calculated in the default setting on modifying the frequency range (span). The insertion loss is also automatically calculated depending on the reference level. The level detectors are coupled to the selected trace mode in the default setting.
The settings which are automatically calculated in the default setting are marked by (*) in the following programming example.

Setting the IEC/IEEE Bus Status Register

```
REM ************************************************************************
Public Sub SetupStatusReg()

'--------- IEEE 488.2 status register -------------------------------------
CALL IBWRT(analyzer%,"*CLS")                    'Reset Status Registers
CALL IBWRT(analyzer%,"*SRE 168")                'Enable service request
                                                'for STAT:OPER-,STAT:QUES- and
                                                'ESR registers
CALL IBWRT(analyzer%,"*ESE 61")                 'Set Event-Enable bit for:
                                                'Operation Complete
                                                'Command-, Execution-,Device
                                                'Dependent- and Query Error
'--------- SCPI status register -------------------------------------------
CALL IBWRT(analyzer%,"STAT:OPER:ENAB 0")        'Disable OPERation Status Reg
CALL IBWRT(analyzer%,"STAT:QUES:ENAB 0")        'Disable Questionable Status
                                                'Register
End Sub
REM ************************************************************************
```

Default Setting for Measurements

```
REM ************************************************************************
Public Sub SetupInstrument()

'-------------------- Basic settings ------------------------------------
CALL SetupStatusReg                          'Set status registers
CALL IBWRT(analyzer%,"*RST")                 'Reset instrument
CALL IBWRT(analyzer%,"SYST:DISP:UPD ON")     'ON: display indication on
                                             'OFF: off(improved
                                             '         performance)
CALL IBWRT(analyzer%,"DISP:FORM SINGle")     'Full screen
CALL IBWRT(analyzer%,"DISP:WIND1:SEL")       'Active screen A
CALL IBWRT(analyzer%,"INIT:CONT OFF")        'Single sweep
'--------- Set frequency -----------------------------------------------
CALL IBWRT(analyzer%,"FREQUENCY:CENTER 100MHz")       'Center frequency
CALL IBWRT(analyzer%,"FREQ:SPAN 1 MHz")               'Span
'--------- Set level ---------------------------------------------------
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:RLEV -20dBm")  'Reference level
CALL IBWRT(analyzer%,"INP:ATT 10dB")                  'Input attenuation (*)
'--------- Scale y-axis ------------------------------------------------
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:SPAC LOG")     'Log level axis
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:SCAL 100dB")   'Level range
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:SCAL:MODE ABS") 'Absolute scaling
CALL IBWRT(analyzer%,"CALC:UNIT:POW DBM")             'Unit of y-axis
'--------- Trace and detector settings ---------------------------------
CALL IBWRT(analyzer%,"DISP:WIND:TRAC1:MODE AVER")     'Trace1 average
CALL IBWRT(analyzer%,"AVER:TYPE VID")                 'Average mode video;
                                                      '"LIN" for linear
CALL IBWRT(analyzer%,"SWE:COUN 10")                   'Sweep count
CALL IBWRT(analyzer%,"DISP:WIND:TRAC2:STAT OFF")      'Trace2 blank
CALL IBWRT(analyzer%,"DISP:WIND:TRAC3:STAT OFF")      'Trace3 blank
CALL IBWRT(analyzer%,"CALC:MATH:STAT OFF")            'Trace mathematics off
CALL IBWRT(analyzer%,"DETECTOR1 RMS")                 'Detector Trace1   (*)
CALL IBWRT(analyzer%,"DET2:AUTO ON")                  'Detector Trace2   (*)
CALL IBWRT(analyzer%,"DET3:AUTO ON")                  'Detector Trace3   (*)
'--------- Band width and sweep time -----------------------------------
CALL IBWRT(analyzer%,"BAND:RES 100KHz")               'Resolution BW (*)
CALL IBWRT(analyzer%,"BAND:VID 1MHz")                 'Video bandwidth   (*)
CALL IBWRT(analyzer%,"SWE:TIM 100ms")                 'Sweep time        (*)
END SUB
REM ************************************************************************
```

Using Marker and Delta Marker

Marker Search Functions, Limitation of Search Range

The example below is based on an AM-modulated signal at 100 MHz with the following characteristics:

- Carrier signal level: –30 dBm
- AF frequency: 100 kHz
- Modulation depth: 50 %

Marker 1 and delta marker 2 are set one after the other to the highest maxima of the measurement curve and then the frequency and level are read out. The default setting of the analyzer can be used for the following measurements (SetupInstrument).

```
REM ************************************************************************
Public Sub MarkerSearch()

result$ = Space$(100)
CALL SetupInstrument                          'Basic setting
'--------- Peak search without search limit ------------------------------
CALL IBWRT(analyzer%,"INIT:CONT OFF")         'Switch to single sweep
CALL IBWRT(analyzer%,"CALC:MARK:PEXC 6DB")    'Peak Excursion
CALL IBWRT(analyzer%,"CALC:MARK:STAT ON")     'Switch on Marker 1
CALL IBWRT(analyzer%,"CALC:MARK:TRAC 1")      'Assign marker1 to Trace 1
CALL IBWRT(analyzer%,"INIT;*WAI")             'Sweep with sync
CALL IBWRT(analyzer%,"CALC:MARK:MAX;X?;Y?")   'Marker to peak; read out
CALL IBRD(analyzer%, result$)                 'frequency and level
Print "Marker 1: ";result$
CALL IBWRT(analyzer%,"CALC:DELT2:STAT ON;MAX;MAX:LEFT")
                                              'Switch on delta marker 2
                                              'Peak and then Next Peak Left
CALL IBWRT(analyzer%,"CALC:DELT:MODE ABS")    'Delta marker 2 frequeny output
                                              'absolute
CALL IBWRT(analyzer%,"CALC:DELT2:X?;Y?")      'Delta marker 2 - Read out
                                              'frequency and level
CALL IBRD(analyzer%, result$)
Print "Delta 2: ";result$
```

```
'--------- Peak search with search limit in x-direction --------------------
CALL IBWRT(analyzer%,"CALC:DELT:MODE REL")    'Delta marker frequency output
                                              'relative

CALL IBWRT(analyzer%,"CALC:MARK:X:SLIM:STAT ON;LEFT 0Hz;RIGHt 100.05MHz")
                                              'Search limit on and set below
                                              'LF on the right side

CALL IBWRT(analyzer%,"CALC:DELT3:STAT ON;MAX;MAX:RIGHt")
                                              'Delta marker 3      on
                                              'Peak and then Next Peak Right
CALL IBWRT(analyzer%,"CALC:DELT3:X?;Y?")      'Delta marker 3; Read out
                                              'frequency und level, both must

CALL IBRD(analyzer%, result$)                 'have the value 0
Print "Delta 3: ";result$

'--------- Peak search with search limit in y-direction --------------------
CALL IBWRT(analyzer%,"CALC:DELT:MODE REL")    'Deltamarker frequency output
                                              'relative

CALL IBWRT(analyzer%,"CALC:THR -35DBM;THR:STAT ON")
                                              'Threshold on and set above LF

CALL IBWRT(analyzer%,"CALC:DELT3:STAT ON;MAX;MAX:NEXT")
                                              'Delta marker 3 on
                                              'Peak and then Next Peak
                                              ' => is not found

CALL IBWRT(analyzer%,"CALC:DELT3:X:REL?;:CALC:DELT:Y?")
CALL IBRD(analyzer%, result$)                 'Delta marker 3; Read out
                                              'Frequency und level, both must
CALL IBRD(analyzer%, result$)                 'have the value 0
Print "Delta 3: ";result$

'---- Set center frequency and reference level by means of markers ---------
CALL IBWRT(analyzer%,"CALC:MARK2:FUNC:CENT") 'Delta marker 2 -> Marker and
                                              'center frequency = Marker 2

CALL IBWRT(analyzer%,"CALC:MARK2:FUNC:REF")   'Ref level = Marker 2

Call ibwrt(analyzer%,"INIT;*WAI")             'Sweep with sync

END SUB

REM ************************************************************************
```

Frequency Counting

The following example is based on a signal with a level of –30 dBm at 100 MHz. The default setting of the analyzer can also be used for this measurement (SetupInstrument). The objective of frequency counting is to determine the exact frequency of the signal at 100 MHz.

```
REM ************************************************************************

Public Sub MarkerCount()


result$ = Space$(100)
CALL SetupInstrument                              'Basic settings
'--------- Measure signal frequency with frequency counter -----------------
CALL IBWRT(analyzer%,"INIT:CONT OFF")             'Single sweep on
CALL IBWRT(analyzer%,"CALC:MARK:PEXC 6DB")        'Peak Excursion
CALL IBWRT(analyzer%,"CALC:MARK:STAT ON")         'Marker 1 on
CALL IBWRT(analyzer%,"CALC:MARK:TRAC 1")          'Assign marker1 to trace 1
CALL IBWRT(analyzer%,"CALC:MARK:X 100MHz")        'Set Marker1 to 100MHz
CALL IBWRT(analyzer%,"CALC:MARK:COUNT:RES 1HZ") 'Frequency counter 1Hz
CALL IBWRT(analyzer%,"CALC:MARK:COUNT ON")        'frequency counter on
CALL IBWRT(analyzer%,"INIT;*WAI")                 'Sweep with sync
CALL IBWRT(analyzer%,"CALC:MARK:COUNT:FREQ?")     'Read out frequency
Print "Marker Count Freq: ";result$
END SUB
REM ************************************************************************
```

Operation mit Fixed Reference Point (Reference Fixed)

The following example is based on a signal with a level of –20 dBm at 100 MHz. The harmonics of the signal lie at 200 MHz, 300 MHz, etc. In the presence of high-quality signal sources these harmonics may lie out of the dynamic range of FSP. In order to measure harmonic suppression, however, the level should be set to higher sensitivity for measuring the harmonics; the carrier has to be suppressed by a notch filter to avoid overloading the analyzer RF input.

In the following example two measurements are therefore performed with different level settings, first with a high reference level at the carrier frequency and then with a low reference level at the frequency of the 3rd harmonic.

The default setting of the analyzer for measurements (SetupInstrument) is used as starting point and adaptations are then made for the measurement.

```
REM ************************************************************************
Public Sub RefFixed()

result$ = Space$(100)
CALL SetupInstrument                              'Basic settings
'--------------- Measure the reference point -------------------------------
CALL IBWRT(analyzer%,"INIT:CONT OFF")             'Single sweep
CALL IBWRT(analyzer%,"CALC:MARK:PEXC 6DB")        'Peak Excursion
CALL IBWRT(analyzer%,"CALC:MARK:STAT ON")         'Marker1 on
CALL IBWRT(analyzer%,"CALC:MARK:TRAC 1")          'Assign marker1 to Trace 1
CALL IBWRT(analyzer%,"INIT;*WAI")                 'Sweep with sync
CALL IBWRT(analyzer%,"CALC:MARK:MAX")             'Set Marker1 to 100MHz
CALL IBWRT(analyzer%,"CALC:DELT:FUNC:FIX ON")     'Reference fixed
'-----Setting freq., level and bandw. for meas. of harmonic distortion ----
CALL IBWRT(analyzer%,"FREQ:CENT 400MHz;Span 1MHz" )'Set freq. of 3rd harmonic
CALL IBWRT(analyzer%,"BAND:RES 1kHz")               'and appropriate RBW
CALL IBWRT(analyzer%,"SWEEP:TIME:AUTO ON")          'Couple sweep time
CALL IBWRT(analyzer%,"INP:ATT:AUTO ON")             'Optimize level
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:RLEV -50dBm")
CALL IBWRT(analyzer%,"INIT;*WAI")                 'Sweep with sync
CALL IBWRT(analyzer%,"CALC:DELT:MODE REL")        'Delta marker frequency
                                                  'relative
CALL IBWRT(analyzer%,"CALC:DELT:MAX;X?;Y?")       'Read out delta marker
Call ibrd(analyzer%, result$)                     'Read out frequency and level
Print "Deltamarker 1: "; result$
END SUB
REM ************************************************************************
```

Phase and Phase Noise Measurement

During phase noise measurement the noise power referred to 1 Hz is brought into proportion to the power of an adjacent carrier signal. The spacing often used between the measured frequency and the carrier frequency is 10 kHz.

For the noise measurement the measured absolute level is referred to a bandwith of 1 Hz.

The following example is again based on a signal with a level of –30 dBM at 100 MHz. Two markers are used to determine the noise and the phase noise at an offset of 10 kHz from the carrier signal.

```
REM ************************************************************************
Public Sub Noise()

result$ = Space$(100)
'--------- Basic settings ------------------------------------------------
CALL SetupStatusReg                          'Configure status register
CALL IBWRT(analyzer%,"*RST")                 'Reset instrument
CALL IBWRT(analyzer%,"INIT:CONT OFF")        'Single sweep
'--------- Set frequency -------------------------------------------------
CALL IBWRT(analyzer%,"FREQUENCY:CENTER 100MHz")       'Center frequency
CALL IBWRT(analyzer%,"FREQ:SPAN 100 kHz")             'Span
'--------- Set level -----------------------------------------------------
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:RLEV -20dBm")  'Reference level
CALL IBWRT(analyzer%,"INIT;*WAI")              'Sweep with sync
'--------- Set reference point -------------------------------------------
CALL IBWRT(analyzer%,"CALC:MARK:PEXC 6DB")     'Peak Excursion
CALL IBWRT(analyzer%,"CALC:MARK:STAT ON")      'Marker1 on
CALL IBWRT(analyzer%,"CALC:MARK:TRAC 1")       'Assign marker1 to trace1
CALL IBWRT(analyzer%,"CALC:MARK:MAX")          'Set marker1 to 100MHz
CALL IBWRT(analyzer%,"CALC:DELT:FUNC:PNO ON")  'Phase Noise on
'--------- Measure phase noise -------------------------------------------
CALL IBWRT(analyzer%,"CALC:DELT:X 10kHz")      'Set delta marker
CALL IBWRT(analyzer%,"CALC:DELT:FUNC:PNO:RES?")'Read out result of
Call ibrd(analyzer%, result$)                  'Phase Noise meas.
Print "Phase Noise [dBc/Hz]: "; result$
'--------- Measure noise -------------------------------------------------
CALL IBWRT(analyzer%,"CALC:MARK:X 99.96MHz")   'Set Marker 1
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:NOIS:RES?")'Read out result
Call ibrd(analyzer%, result$)
Print "Noise [dBm/Hz]: "; result$

END SUB

REM ************************************************************************
```

Shape Factor Measurement (using n-dB down)

The n-dB-down function of the analyzer is used twice to determine the shape factor of a filter (ratio of bandwidths at 60 dB and 3 dB below the filter maximum).

The following example is again based on a signal with a level of –30 dBm at 100 MHz. The shape factor is determined for the 30 kHz resolution bandwidth. The default setting of the analyzer is used for measurements (SetupInstrument).

```
REM ************************************************************************

Public Sub ShapeFactor()


result$ = Space$(100)
'--------- Basic settings analyzer ----------------------------------------
CALL SetupInstrument                            'Basic settings
CALL IBWRT(analyzer%,"INIT:CONT OFF")           'Single sweep
'--------- Set frequency --------------------------------------------------
CALL IBWRT(analyzer%,"FREQ:SPAN 1MHz")          'Span
CALL IBWRT(analyzer%,"BAND:RES 30kHz")          'Resolution bandwidth
CALL IBWRT(analyzer%,"INIT;*WAI")               'Sweep with sync
'--------- Measure 60 dB value --------------------------------------------
CALL IBWRT(analyzer%,"CALC:MARK:PEXC 6DB")      'Peak Excursion
CALL IBWRT(analyzer%,"CALC:MARK:STAT ON")       'Marker1 on
CALL IBWRT(analyzer%,"CALC:MARK:TRAC 1")        'Assign marker1 to Trace 1
CALL IBWRT(analyzer%,"CALC:MARK:MAX")           'Set marker1 to 100MHz
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:NDBD 60dB")'Bandbreite bei 60dB messen
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:NDBD:RES?")'und auslesen
CALL IBRD(analyzer%,result$)
result60 = Val(result$)
'--------- Measure 3 dB Down value  ---------------------------------------
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:NDBD 3dB")'Read out bandwidth at 60dB
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:NDBD:RES?")
CALL IBRD(analyzer%,result$)
result3 = Val(result$)
'--------- Read out shape factor-------------------------------------------
Print "Shapefaktor 60dB/3dB: ";result60/result3
END SUB

REM ************************************************************************
```

Measuring the Third Order Intercept Point

The intercept point of 3rd order is the (virtual) level of two adjacent useful signals at which the intermodulation products of 3rd order have the same level as the useful signals.

The intermodulation product at f_{S2} is obtained by mixing the first harmonic of useful signal P_{N2} with signal P_{N1}, the intermodulation product at f_{S1} by mixing the first harmonic of useful signal P_{N1} with signal P_{N2}.

$f_{s1} = 2 \times f_{n1} - f_{n2}$ (1)

$f_{s2} = 2 \times f_{n2} - f_{n1}$ (2)

The following example is based on two adjacent signals with a level of –30 dBm at 100 MHz and 110 MHz. The intermodulation products lie at 90 MHz and 120 MHz according to the above formula. The frequency set is such that the examined mixture products are displayed on the diagram. Otherwise the default setting of the analyzer is used for measurements (SetupInstrument).

```
REM ************************************************************************
Public Sub TOI()

result$ = Space$(100)
'--------- Basic settings ------------------------------------------------
CALL SetupStatusReg                          'Set status registers
CALL IBWRT(analyzer%,"*RST")                 'Reset instrument
CALL IBWRT(analyzer%,"INIT:CONT OFF")        'Single sweep
CALL IBWRT(analyzer%,"SYST:DISP:UPD ON")     'ON: display indication on
                                             'OFF: off
'--------- Set frequency -------------------------------------------------
CALL IBWRT(analyzer%,"FREQ:STARt 85MHz;STOP 125 MHz") 'Span
'--------- Set level -----------------------------------------------------
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:RLEV -20dBm")  'Reference level
CALL IBWRT(analyzer%,"INIT;*WAI")              'Sweep with sync
'--------- TOI measurement -----------------------------------------------
CALL IBWRT(analyzer%,"CALC:MARK:PEXC 6DB")     'Peak Excursion
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:TOI ON")  'TOI on
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:TOI:RES?")'and read out results
CALL IBRD(analyzer%,result$)
'--------- Read out result -----------------------------------------------
Print "TOI [dBm]: ";result$
END SUB
REM ************************************************************************
```

Measuring the AM Modulation Depth

The example below is based on an AM-modulated signal at 100 MHz with the following characteristics:

- Carrier signal level: –30 dBm
- AF frequency: 100 kHz
- Modulation depth: 50 %

The default setting of the analyzer for measurements can be used for the measurements described below (SetupInstrument).

```
REM ********************************************************************************

Public Sub AMMod()


result$ = Space$(100)

CALL SetupInstrument                              'Basic settings

'--------- Peak search ------------------------------------------------------

CALL IBWRT(analyzer%,"INIT:CONT OFF")             'Single sweep
CALL IBWRT(analyzer%,"INIT;*WAI")                 'Sweep with sync

CALL IBWRT(analyzer%,"CALC:MARK:PEXC 6DB")        'Peak Excursion
CALL IBWRT(analyzer%,"CALC:MARK:STAT ON")         'Marker 1 on
CALL IBWRT(analyzer%,"CALC:MARK:TRAC 1")          'Assign marker1 to trace 1

'--------- Measure modulation depth-----------------------------------------

CALL IBWRT(analyzer%,"CALC:MARK:MAX;FUNC:MDEP ON") 'Marker to Peak;
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:MDEP:RES?")   'Mod. Depth on
CALL IBRD(analyzer%, result$)                      'Read out result

'--------- Read out result -------------------------------------------------

Print "AM Mod Depth [%]: ";result$

END SUB

REM ********************************************************************************
```

Limit Lines and Limit Test

The example below shows the definition and use of a new limit line 5 for trace 1 on screen A and trace 2 on screen B with the following characteristics:

- Upper limit line
- Absolute x axis in the frequency range
- 5 reference values: 120 MHz / -70 DB, 126 MHz/-40 dB, 127 MHz/-40 dB, 128 MHz/-10 dB, 129 MHz/-40 dB, 130 MHz/-40 dB, 136 MHz / - 70 dB
- Relative y axis with unit dB
- Absolute threshold at -75 dBm
- No margin

The signal of the integrated calibration source (128 MHz, -30 dBm) is used to check the limit test.

```
REM ************************************************************************
Public Sub LimitLine()

result$ = Space$(100)
'--------- Basic settings -----------------------------------------------
CALL SetupInstrument                                    'Basic settings
CALL IBWRT(analyzer%,"FREQUENCY:CENTER 128MHz;Span 10MHz")'Span
Call ibwrt(analyzer%,"Diag:Serv:Inp Cal;CSO -30dBm")   'Cal signal on
'--------- Definition of limit lines ------------------------------------
CALL IBWRT(analyzer%,"CALC:LIM5:NAME 'TEST1'")          'Define name
CALL IBWRT(analyzer%,"CALC:LIM5:COMM 'Upper limit'")    'Define comment
CALL IBWRT(analyzer%,"CALC1:LIM5:TRAC 1")       'Assign trace in screen A
CALL IBWRT(analyzer%,"CALC2:LIM5:TRAC 2")       'Assign trace in screen B
CALL IBWRT(analyzer%,"CALC:LIM5:CONT:DOM FREQ") 'Define x-axis range
CALL IBWRT(analyzer%,"CALC:LIM5:CONT:MODE ABS") 'Define x-axis scaling
CALL IBWRT(analyzer%,"CALC:LIM5:UNIT DB")       'Define y-axis unit
CALL IBWRT(analyzer%,"CALC:LIM5:UPP:MODE REL")  'Define y-axis scaling
'--------- Definition of data points and threshold ----------------------
xlimit$ = "CALC:LIM5:CONT 120MHZ,126MHZ,127MHZ,128MHZ,129MHZ,130MHz,136MHz"
CALL IBWRT(analyzer%, xlimit$)                  'Set values for x-axis
CALL IBWRT(analyzer%,"CALC:LIM5:UPP -70,-40,-40,-20,-40,-40,-70")
                                                'Set values for y-axis

CALL IBWRT(analyzer%,"CALC:LIM5:UPP:THR -75DBM") 'Set y-threshold (only
                                                  'possible for relative
                                                  'y-axis)
'------------------------------------------------------------------------
'A margin or an x-/y offset can be defined here.
'----------- Activate and evaluate the limit line in screen A ------------
CALL IBWRT(analyzer%,"CALC1:LIM5:UPP:STAT ON")  'Activate line 5 in screen A
CALL IBWRT(analyzer%,"CALC1:LIM5:STAT ON")      'Activate limit check in
                                                'screen A
CALL IBWRT(analyzer%,"INIT;*WAI")               'Sweep with sync
```

```
CALL IBWRT(analyzer%,"CALC1:LIM5:FAIL?")        'Query result of limit
                                                'check
CALL IBRD(analyzer%, result$)                   'Result: 1 (= FAIL)
'--------- Read out result ------------------------------------------------
Print "Limit Result Line 5: ";result$

'------ Evaluate limit line in screen A by means of status registers -------
CALL IBWRT(analyzer%,"*CLS")                   'Reset status register
'--------- Measure -------------------------------------------------------
CALL IBWRT(analyzer%,"INIT;*OPC")              'Sweep with sync
CALL WaitSRQ(boardID%,status%)                 'Wait for service request
'--------- Read out result ------------------------------------------------
IF (status% = 1) THEN
   CALL IBWRT(analyzer%,"STAT:QUES:LIM1:COND?") 'Read out STAT:QUES:LIMit
   CALL IBRD(analyzer%, result$)                'register
   IF ((Val(result$) And 16) <> 0) THEN
      Print "Limit5 failed"
   ELSE
      Print "Limit5 passed"
   END IF
END IF
END SUB
REM ***************************************************************************
```

Measuring the Channel and Adjacent Channel Power

In the following example the channel and adjacent channel power is first measured on a signal with a level of 0 dBm at 800 MHz to IS95. Then the channel and adjacent channel power is measured on a GSM signal at 935.2 MHz with fast ACP measurement (FAST ACP).

In addition, the limit test is activated.

```
REM ************************************************************************
Public Sub ACP()

result$ = Space$(100)
'--------- Basic settings ------------------------------------------------
CALL SetupStatusReg                          'Set status register
CALL IBWRT(analyzer%,"*RST")                 'Reset instrument
CALL IBWRT(analyzer%,"INIT:CONT OFF")        'Single sweep
CALL IBWRT(analyzer%,"SYST:DISP:UPD ON")     'ON: display indication on
                                             'OFF: off
'--------- Set frequency -------------------------------------------------
CALL IBWRT(analyzer%,"FREQ:CENT 800MHz")       'Set frequency
'--------- Set level -----------------------------------------------------
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:RLEV 10dBm")    'Reference level

'--------- Example 1: Configure CP/ACP for CDMA  -------------------------
CALL IBWRT(analyzer%,"CALC2:MARK:FUNC:POW:SEL ACP")    'ACP measurement on
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:POW:PRES F8CDMA") 'Select CDMA800 FWD
CALL IBWRT(analyzer%,"SENS:POW:ACH:ACP 2")      'Select 2 adjacent channels
CALL IBWRT(analyzer%,"SENS:POW:ACH:PRES ACP")   'Optimize settings
CALL IBWRT(analyzer%,"SENS:POW:ACH:PRES:RLEV")  'Optimize reference level
CALL IBWRT(analyzer%,"SENS:POW:ACH:MODE ABS")   'Absolute measurement
CALL IBWRT(analyzer%,"SENS:POW:HSP ON")         'Fast ACP measurement
'--------- Measure and query result --------------------------------------
CALL IBWRT(analyzer%,"INIT;*WAI")               'Sweep with sync
CALL IBWRT(analyzer%,"CALC2:MARK:FUNC:POW:RES? ACP")   'Query result
CALL IBRD(analyzer%, result$)
'--------- Read out result -----------------------------------------------
Print "Result (CP, ACP low, ACP up, Alt low, Alt up): "
Print result$
```

```
'--------- Example 2: Configure CP/ACP manually für GSM ------------------

result$ = Space$(100)

CALL IBWRT(analyzer%,"FREQ:CENT 935.2MHz")      'Set frequency

CALL IBWRT(analyzer%,"CALC:MARK:FUNC:POW:SEL ACP")  'ACP measurement on

CALL IBWRT(analyzer%,"SENS:POW:ACH:ACP 1")          '1 adjacent channel

CALL IBWRT(analyzer%,"SENS:POW:ACH:BAND 200KHZ")    'Channel band width
CALL IBWRT(analyzer%,"SENS:POW:ACH:BAND:ACH 200KHZ")'Adjacent channel bandw.
CALL IBWRT(analyzer%,"SENS:POW:ACH:SPAC 200KHZ")    'Channel spacing

CALL IBWRT(analyzer%,"SENS:POW:ACH:PRES ACP")   'Optimize settings
CALL IBWRT(analyzer%,"SENS:POW:ACH:PRES:RLEV") 'Optimize reference level

CALL IBWRT(analyzer%,"SENS:POW:ACH:MODE ABS")   'Absolute measurement
'--------- Start measurement and query result ----------------------------

CALL IBWRT(analyzer%,"INIT;*WAI")               'Sweep with sync

CALL IBWRT(analyzer%,"CALC:MARK:FUNC:POW:RES? ACP")    'Query result
CALL IBRD(analyzer%, result$)

'--------- Read out result -----------------------------------------------

Print "Result (CP, ACP low, ACP up): "
Print result$

'--------- Active limit check --------------------------------------------

result$ = Space$(100)

CALL IBWRT(analyzer%,"CALC:LIM:ACP:ACH 30DB, 30DB")    'Set relative limit

CALL IBWRT(analyzer%,"CALC:LIM:ACP:ACH:ABS -35DBM,-35DBM")
                                                'Set absolute limit

CALL IBWRT(analyzer%,"CALC:LIM:ACP:ACH:STAT ON")       'Rel. limit check on
CALL IBWRT(analyzer%,"CALC:LIM:ACP:ACH:ABS:STAT ON")   'Abs. limit check on
CALL IBWRT(analyzer%,"CALC:LIM:ACP ON")                'Limit check on

'--------- Start measurement and query result ----------------------------

CALL IBWRT(analyzer%,"INIT;*WAI")                      'Sweep with sync

CALL IBWRT(analyzer%,"CALC:LIM:ACP:ACH:RES?")          'Query result of
CALL IBRD(analyzer%, result$)                          'limit check

'--------- Read out result -----------------------------------------------

Print "Result Limit Check: ";result$

END SUB

REM ************************************************************************
```

Occupied Bandwidth Measurement

In the following example, the bandwidth is to be found in which 95% of the power of a GSM signal is contained. Signal frequency is 935,2 MHz; channel bandwidth is 200 kHz.

```
REM ************************************************************************
Public Sub OBW()

result$ = Space$(100)
'--------- Basic settings ------------------------------------------------
CALL SetupStatusReg                          'Set status register
CALL IBWRT(analyzer%,"*RST")                 'Reset instrument
CALL IBWRT(analyzer%,"INIT:CONT OFF")        'Single sweep
CALL IBWRT(analyzer%,"SYST:DISP:UPD ON")     'ON: display indication on
                                             'OFF: off
'--------- Configure analyzer for OBW for GSM  ---------------------------
CALL IBWRT(analyzer%,"FREQ:CENT 935.2MHz")          'Set frequency
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:POW:SEL OBW")  'OBW measurement on
CALL IBWRT(analyzer%,"SENS:POW:ACH:BAND 200KHZ")    'Channel bandwidth
CALL IBWRT(analyzer%,"SENS:POW:BWID 95PCT")     'Percentage of power
CALL IBWRT(analyzer%,"SENS:POW:ACH:PRES OBW")   'Set frequency and
CALL IBWRT(analyzer%,"SENS:POW:ACH:PRES:RLEV") 'optimize level settings
CALL IBWRT(analyzer%,"SENS:POW:NCOR OFF")       'Noise correction
'--------- Measure and query result --------------------------------------
CALL IBWRT(analyzer%,"INIT;*WAI")               'Sweep with sync
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:POW:RES? OBW")    'Query result
CALL IBRD(analyzer%, result$)
Print result$
END SUB
REM ************************************************************************
```

Time Domain Power Measurement

In the following example the mean carrier power of a signal with 300 kHz bandwith at 100 MHz is to be determined. In addition, the peak power, the rms value and the standard deviation are measured. To do this, the time-domain-power measurement functions are used.

```
REM ************************************************************************

Public Sub TimeDomainPower()


result$ = Space$(100)
'--------- Basic settings ------------------------------------------------

CALL SetupStatusReg                          'Set status register

CALL IBWRT(analyzer%,"*RST")                 'Reset instrument

CALL IBWRT(analyzer%,"INIT:CONT OFF")        'Single sweep

CALL IBWRT(analyzer%,"SYST:DISP:UPD ON")     'ON: display indication on
                                             'OFF: off

'--------- Configure analyzer for time domain power measurement ------------

CALL IBWRT(analyzer%,"FREQ:CENT 100MHz;SPAN 0Hz")    'Set frequency
CALL IBWRT(analyzer%,"BAND:RES 300kHz")              'Resolution bandwidth
CALL IBWRT(analyzer%,"SWE:TIME 200US")               'Sweep time

CALL IBWRT(analyzer%,"CALC:MARK:FUNC:SUMM:PPE ON")   'Pos. Peak measurement
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:SUMM:MEAN ON")  'Mean measurement
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:SUMM:RMS ON")   'RMS measurement
CALL IBWRT(analyzer%,"CALC:MARK:FUNC:SUMM:SDEV ON")  'Standard deviation

'------------------- Measure and query results ----------------------------

CALL IBWRT(analyzer%,"INIT;*WAI")                    'Sweep with sync

                                                     'Query results:
query$ =          " CALC:MARK:FUNC:SUMM:PPE:RES?;"   'Pos. Peak measurement
query$ = query$ + ":CALC:MARK:FUNC:SUMM:MEAN:RES?;"  'Mean measurement
query$ = query$ + ":CALC:MARK:FUNC:SUMM:RMS:RES?;"   'RMS measurement
query$ = query$ + ":CALC:MARK:FUNC:SUMM:SDEV:RES?"   'Standard deviation
Call IBWRT(analyzer%, query$)

CALL IBRD(analyzer%, result$)

Print result$

END SUB

REM ************************************************************************
```

Reading Trace Data

In the following example the trace data recorded together at the default setting are read out of the instrument and displayed on the screen in the form of a list. Reading is performed consecutively in the binary format and in the ASCII format, at span > 0 and also at span = 0.

In the binary format the message header is evaluated with the length indication and used to calculate the x axis values.

In the ASCII format only the list of level values is output.

The binary data are read out in 3 steps:

1. Reading the number of digits of the length indication
2. Reading the length indication
3. Reading trace data

This procedure is necessary with programming languages that support only structures with similar data types (arrays) (such as Visual Basic) since the data types of header and data differ in binary data.

```
REM ************************************************************************
Public Sub ReadTrace()

'--------- Define variables ------------------------------------------------
Dim traceData(1002) As Single                 'Buffer for floating point
                                              'binary data
Dim digits As Byte                            'Number of digits of
                                              'length indication
Dim traceBytes As Integer                     'Length of trace data in bytes
Dim traceValues As Integer                    'Number of values in buffer
asciiResult$ = Space$(10000)                  'Buffer for ASCII trace data
result$ = Space$(100)                         'Buffer for simple results
startFreq$ = Space$(100)                      'Buffer for start frequency
span$ = Space$(100)                           'Buffer for span
'--------- Basic settings --------------------------------------------------
CALL SetupInstrument                          'Basic settings
CALL IBWRT(analyzer%,"INIT:CONT OFF")         'Single sweep
CALL IBWRT(analyzer%,"INIT;*WAI")             'Sweep with sync
'--------- Define span for read out ----------------------------------------
Call ibwrt(analyzer%,"FREQ:STARt?")           'Read out start frequency
Call ibrd(analyzer%,startFreq$)
startFreq = Val(startFreq$)
Call ibwrt(analyzer%,"FREQ:SPAN?")            'Read out span
Call ibrd(analyzer%,span$)
span = Val(span$)
```

```
'--------- Read out in binary format ------------------------------------
Call ibwrt(analyzer%, "FORMAT REAL,32")       'Select binary format
Call ibwrt(analyzer%, "TRAC1? TRACE1")        'Read out Trace 1
Call ilrd(analyzer%, result$, 2)              'Read out and store
digits = Val(Mid$(result$, 2, 1))             'number of digits of
                                              'length indication
result$ = Space$(100)                         'Initialize buffer again
Call ilrd(analyzer%, result$, digits)         'Read out
traceBytes = Val(Left$(result$, digits))      'and store indication of length
Call ibrd32(analyzer%, traceData(0), traceBytes) 'Read trace data into buffer
'--------- Read out binary data as pairs of frequency/level values ---------
traceValues = traceBytes/4                    'Single precision = 4 bytes
stepsize = span/traceValues                   'Calculate frequeny step width
For i = 0 To traceValues - 1
  Print "Value["; i; "] = "; startFreq+stepsize*i; ", "; traceData(i)
Next i
'--------- Basic settings time domain -----------------------------------
Call ibwrt(analyzer%,"FREQ:SPAN 0Hz")         'Zero span on
CALL IBWRT(analyzer%,"INIT;*WAI")             'Sweep with sync
'--------- Read out in ASCII format -------------------------------------
Call ibwrt(analyzer%,"FORMAT ASCII")          'Select ASCII format
CALL ibwrt(analyzer%,"TRAC1? TRACE1")         'Read out Trace 1
CALL ibrd(analyzer%, asciiResult$)
Print "Contents of Trace1: ",asciiResult$
END SUB
REM ************************************************************************
```

Storing and Loading Device Settings

Storing Instrument Settings

In the following example the settings/measurement data to be stored are determined; only the hardware settings are stored. The selection commands for the other settings are indicated with the status OFF for the sake of completeness.

```
REM ************************************************************************

Public Sub StoreSettings()


'This subroutine selects the settings to be stored and creates
'the data set "TEST1" in directory D:\USER\DATA. It uses
'the default setting and resets the instrument after storage
'of the setting.

'--------- Basic settings ------------------------------------------------

Call SetupInstrument
CALL IBWRT(analyzer%,"INIT:CONT OFF")        'Single sweep
CALL IBWRT(analyzer%,"INIT;*WAI")            'Sweep with sync

'--------- Select items to store -----------------------------------------

CALL IBWRT(analyzer%,"MMEM:SEL:HWS ON")      'Select hardware settings to
                                             'store
CALL IBWRT(analyzer%,"MMEM:SEL:TRAC OFF")    'Disable traces to store
CALL IBWRT(analyzer%,"MMEM:SEL:LIN:ALL OFF") 'Select active limit lines to
                                             'store

'--------- Define comment ------------------------------------------------

CALL IBWRT(analyzer%,"MMEM:COMM 'Test Setup'")

'--------- Store selected items ------------------------------------------

CALL IBWRT(analyzer%,"MMEM:STOR:STAT 1,'D:\USER\DATA\TEST1'")

'--------- Reset instrument ----------------------------------------------

CALL IBWRT(analyzer%,"*RST")

END SUB

REM ************************************************************************
```

Loading Device Settings

In the following example data set "TEST1" stored under D:\USER\DATA is reloaded into the isnstrument:

```
REM ************************************************************************
Public Sub LoadSettings()

'This subroutine loads data set "TEST1" in directory D:\USER\DATA.
'--------- Set status registers ------------------------------------------
Call SetupStatusReg                          'Set status register
'--------- Load data set -------------------------------------------------
CALL IBWRT(analyzer%,"MMEM:LOAD:STAT 1,'D:\USER\DATA\TEST1'")
'----Start measurement with the settings of the loaded data set ------------
CALL IBWRT(analyzer%,"INIT;*WAI")
END SUB
REM ************************************************************************
```

Setting the Data Set for Startup Recall

In the following example the analyzer is first reset. Then the data set TEST1 stored under D:\USER\DATA is selected for the function STARTUP RECALL, ie the data set is set for every *RST, PRESET and every device startup. For illustration, the command *RST is executed again.

```
REM ************************************************************************
Public Sub StartupRecallSettings()
'--------- Reset analyzer ------------------------------------------------
CALL IBWRT(analyzer%,"*RST")
'--------- Set status registers ------------------------------------------
Call SetupStatusReg                          'Set status register
'--------- Select startup recall data set---------------------------------
CALL IBWRT(analyzer%,"MMEM:LOAD:AUTO 1,'D:\USER\DATA\TEST1'")
'--------- Activate startup recall data set ------------------------------
CALL IBWRT(analyzer%,"*RST")
END SUB
REM ************************************************************************
```

Reading and Writing Files

Reading a File from the Instrument

In the following example file TEST1.SET stored under D:\USER\DATA is read from the instrument and stored in the controller.

```
REM ********************************************************************************
Public Sub ReadFile()
'--------- Variables -------------------------------------------------------
Dim digits As Byte                          'Number of digits of
                                            'length indication
Dim fileBytes As Long                       'Length of file with trace data
                                            'in bytes
result$ = Space$(100)                       'Buffer for simple results
'--------- Basic settings status registers ---------------------------------
Call SetupStatusReg                         'Set status register
'--------- Read out file ---------------------------------------------------
Call ibwrt(analyzer%, "MMEM:DATA? 'D:\USER\DATA\TEST1.SET'")
                                            'Select file
Call ilrd(analyzer%, result$, 2)            'Read and store number of
                                            'digits in length
digits = Val(Mid$(result$, 2, 1))           'indication
Call ilrd(analyzer%, result$, digits)       'Read and store length
fileBytes = Val(Left$(result$, digits))     'indication
FileBuffer$ = Space$(fileBytes)             'Buffer for file
Call ilrd(analyzer%, FileBuffer, fileBytes) 'Read file into buffer
'--------- Store file to controller ----------------------------------------
Open "TEST1.SET" For Output As #1
Print #1, FileBuffer;                       ' ; to avoid linefeed at
                                            '   end of file
Close #1
END SUB
REM ********************************************************************************
```

Creating a File in the Instrument

In the following example file TEST1.SET available on the controller is stored in the instrument under D:\USER\DATA\DUPLICAT.SET.

```
REM ************************************************************************

Public Sub WriteFile()

'--------- Variables -----------------------------------------------------

FileBuffer$ = Space$(100000)                    'Buffer for file
Dim digits As Long                              'Number of digits of
                                                'length indication
Dim fileBytes As Long                           'Length of file in bytes
fileSize$ = Space$(100)                         'Length of file in a string

result$ = Space$(100)                           'Buffer for simple results

'--------- Basic settings status registers -------------------------------

Call SetupStatusReg                             'Set status register

'--------- Prepare the definite length block data ------------------------

fileBytes = FileLen("H:\work\vb\test1.set")  'Determine length of file
fileSize$ = Str$(fileBytes)

digits = Len(fileSize$) - 1                     'Determine number of digits of
fileSize$ = Right$(fileSize$, digits)           'length indication

FileBuffer$ = "#" + Right$(Str$(digits), 1) + fileSize$
                                                'Put length indication into
                                                'file buffer

'--------- Read file from controller -------------------------------------

Open "H:\work\vb\TEST1.SET" For Binary As #1

FileBuffer$ = FileBuffer$ + Left$(Input(fileBytes, #1), fileBytes)

Close #1

'--------- Write file ----------------------------------------------------
-

Call ibwrt(analyzer%, "SYST:COMM:GPIB:RTER EOI")      'Set receive
                                                      'terminator in the
                                                      'instrument

Call ibwrt(analyzer%, "MMEM:DATA 'D:\USER\DATA\DUPLICAT.SET'," +
           FileBuffer$)                               'Select file

END SUB

REM ************************************************************************
```

Configuring and Starting a Printout

The following example shows the configuration of the output format and output device for printing out a measurement mask.
The procedure is in the following order:

1. Set the measurement required for the printout
2. Query available output devices
3. Select an output device
4. Select the output interface
5. Configure the output format
6. Start printout with synchronization to the end

It is assumed that the setting required is a signal with a power of –20 dBm at 100 MHz and also that the printer required is the 6th of the available printers. The printout is first performed to the selected printer, then to a file.

```
REM ************************************************************************
Public Sub HCopy()

DIM Devices(100) as string                          'Buffer for printer name
FOR i = 0 TO 49
   Devices$(i) = Space$(50)                         'Preallocate buffer for
                                                    'printer name
NEXT i
'--------- Basic settings -----------------------------------------------
CALL SetupStatusReg                                 'Set status register
CALL IBWRT(analyzer%,"*RST")                        'Reset instrument
CALL IBWRT(analyzer%,"INIT:CONT OFF")               'Single sweep
CALL IBWRT(analyzer%,"SYST:DISP:UPD ON")            'Display indication on
'--------- Configure measurement ----------------------------------------
CALL IBWRT(analyzer%,"FREQ:CENT 100MHz;SPAN 10MHz")     'Set frequency
CALL IBWRT(analyzer%,"DISP:WIND:TRAC:Y:RLEV -10dBm")    'Reference level
CALL IBWRT(analyzer%,"INIT;*WAI")                       'Start measurement
'--------- Query available output devices -------------------------------
CALL IBWRT(analyzer%,"SYST:COMM:PRIN:ENUM:FIRSt?")      'Read out first
CALL IBRD(analyzer%,Devices$(0))                        'printer and indicate
PRINT "Drucker 0: "+Devices$(0)                         'printer name
For i = 1 to 99
   CALL IBWRT(analyzer%,"SYST:COMM:PRIN:ENUM:NEXT?")    'Read out the next
   CALL IBRD(analyzer%,Devices$(i))                     'printer name
   IF Left$(Devices$(i),2) = "''" THEN GOTO SelectDevice 'Abort at end of
                                                        'list
   PRINT "Drucker"+Str$(i)+": " Devices$(i)             'Indicate printer name
NEXT i
```

```
SelectDevice:
'------------ Select device, printer language and interface ---------------
CALL IBWRT(analyzer%,"SYST:COMM:PRIN:SEL "+ Devices(6))'Select printer #6
8 CALL IBWRT(analyzer%,"HCOP:DEST 'SYST:COMM:PRIN'")  'Configuration:
                                                      '"Print out to
                                                      'printer interface"
CALL IBWRT(analyzer%,"HCOP:DEV:LANG GDI")           'Output language 'GDI'
'----- Select orientation (portrait/landscape) and color/BW ---------------
CALL IBWRT(analyzer%,"HCOP:PAGE:ORI PORTrait")      'Portrait
CALL IBWRT(analyzer%,"HCOP:DEV:COL OFF")            'Black and white
'----- Configure and start print out --------------------------------------
 CALL IBWRT (analyzer%,"HCOP:ITEM:ALL")       'Select complete screen
'CALL IBWRT (analyzer%,"HCOP:ITEM:WIND1:TRAC:STAT ON")  'alternative: only
'CALL IBWRT (analyzer%,"HCOP:ITEM:WIND2:TRAC:STAT ON")  'traces in
                                                        'screen A/B
CALL IBWRT (analyzer%,"*CLS")                   'Reset status registers
CALL IBWRT (analyzer%,"HCOP:IMMediate;*OPC")    'Start print out
CALL WaitSRQ(boardID%,result%)                  'Wait for service request
IF (result% = 1) THEN CALL Srq                  'If SRQ is recognized =>
                                                'Subroutines for evaluation
'---- Print out into file in WMF format (BMP format) ----------------------
CALL IBWRT(analyzer%,"HCOP:DEST 'MMEM'")        'Configuration:
                                                '"Print to file"
 CALL IBWRT(analyzer%,"HCOP:DEV:LANG WMF")      'File format WMF
'CALL IBWRT(analyzer%,"HCOP:DEV:LANG BMP")      'File format BMP
CALL IBWRT(analyzer%,"MMEM:NAME 'D:\USER\DATA\PRINT1.WMF'") 'Determine
                                                            'file name
CALL IBWRT (analyzer%,"*CLS")                   'Reset status registers
CALL IBWRT (analyzer%,"HCOP:IMMediate;*OPC")    'Start print out
CALL WaitSRQ(boardID%,result%)                  'Wait for service request
IF (result% = 1) THEN CALL Srq                  'If SRQ is recognized  =>
                                                'Subroutines for evaluation
END SUB
REM ***************************************************************************
```

Contents - Chapter 8 "Maintenance and Instrument Interfaces"

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8 Maintenance and Instrument Interfaces

The following chapter contains information on the maintenance of the FSP and on the instrument interfaces.

Please follow the instructions in the service manual when exchanging modules or ordering spares. The order no. for spare parts can be found in the service manual.

The address of our support center and a list of all Rohde & Schwarz service centers can be found at the beginning of this manual.

The service manual includes further information particularly on troubleshooting, repair, exchange of modules (including battery exchange, adjustment of the OCXO oscillator) and calibration.

Maintenance

Mechanical and Electrical Maintenance

The CMU does not require any special maintenance. Remove any contamination on the instrument by means of a soft cloth. Make sure that the air vents are not obstructed.

Storing and Packing

The FSP can be stored at a temperature of –5°C to +60°C. When stored for an extended period of time the instrument should be protected against dust.

The original packing should be used, particularly the protective covers at the front and rear, when the instrument is to be transported or dispatched. If the original packing is no longer available, use a sturdy cardboard box of suitable size and carefully wrap the instrument to protect it against mechanical damage.

List of Power Cables Available

Table 8-1 List of power cables available

Stock No.	Earthed-contact connector	Preferably used in
DS 006.7013	BS1363: 1967' complying with IEC 83: 1975 standard B2	Great Britain
DS 006.7020	Type 12 complying with SEV-regulation 1011.1059, standard sheet S 24 507	Switzerland
DS 006.7036	Type 498/13 complying with US-regulation UL 498, or with IEC 83	USA/Canada
DS 006.7107	Type SAA3 10 A, 250 V, complying with AS C112-1964 Ap.	Australia
DS 0025.2365 DS 0099.1456	DIN 49 441, 10 A, 250 V, angular DIN 49 441, 10 A, 250 V, straight	Europe (except Switzerland)

Instrument Interfaces

AF Output

A miniature telephone jack can be used at the AF OUTPUT connector to connect an external loudspeaker, a headphone set or, e.g., a LF voltmeter. The internal resistance is 10 ohms and the output voltage can be controlled with the volume controller on the left side to the connector. When a jack is plugged in, the internal loudspeaker is automatically turned off.

The connector is only available with option FSP-B3, AF demodulator.

Probe Connector (PROBE POWER)

To allow the connection of probes, the FSP provides the PROBE POWER power connector. It delivers the power supply voltages +15 V and -12,6 V and ground.

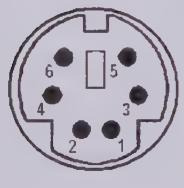
The connector is also suited for powering the high-impedance probes from Hewlett Packard.

Pin	Signal
1	GND
2	-12,6 V; max 150 mA
3	+15 V; max 150 mA

Fig. 8-1 Pin assignments of PROBE POWER connector

External Keyboard (KEYBOARD)

A 6-pin PS/2 connector is provided on the front panel to allow connecting an external keyboard. The PSP-Z1 keyboard (Order No. 1091.4000.02, german) or the PSP-Z2 (Order No. 1091.4100.02, english) is recommended (Order No. 1009.5001.31). Also they include a trackball for mouse control. However, any other multi-function keyboard may also be used.



Pin	Signal
1	KEYBOARDDATA
2	MOUSEDATA
3	GND
4	5V, KEYBOARD
5	KEYBOARDCLK
6	MOUSECLK

Fig 8-2 Pin assignments of the KEYBOARD connector.

IEC Bus Interface

The standard instrument is equipped with an IEC/IEEE Bus connector. An IEEE 488 interface connector is located on the rear panel of the FSP. An external controller for remote control of the instrument can be connected via the IEEE 488 interface connector using a shielded cable.

Interface Characteristics

- 8-bit parallel data transfer
- bi-directional data transfer
- three-line handshake
- high data transfer rate of max. 350 kbyte/s
- up to 15 instruments can be connected
- maximal length of the interconnecting cables 15 m (single connection, 2m)
- wired-OR connection if several instruments are connected in parallel.

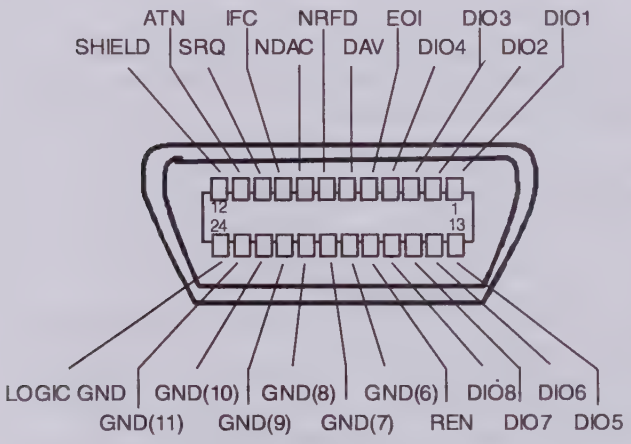


Fig. 8-3 Pin assignment of IEC-Bus interface

Bus Lines

1. **Data bus with 8 lines DIO 1 to DIO 8.**
   The transmission is bit-parallel and byte-serial in the ASCII/ISO code. DIO1 is the least significant, DIO8 the most significant bit.

2. **Control bus with 5 lines.**
   IFC (Interface Clear),
   active low resets the interfaces of the devices connected to the default setting.

   ATN (Attention),
   active low signals the transmission of interface messages
   inactive high signals the transmission of device messages.

   SRQ (Service Request),
   active low enables a device connected to send a service request to the controller.

REN (Remote Enable),
active low permits the switch over to remote control.

EOI (End or Identify),
has two functions in connection with ATN:
active low marks the end of data transmission when ATN=high
active low triggers a parallel poll when ATN=low.

3. **Handshake bus with three lines.**
DAV (Data Valid),
active low signals a valid data byte on the data bus.

NRFD (Not Ready For Data),
active low signals that one of the devices connected is not ready for data transfer .

NDAC (Not Data Accepted),
active low as long as the device connected is accepting the data present on the data bus.

Interface Functions

Instruments which can be remote controlled via the IEC bus can be equipped with different interface functions. Table 8-2 lists the interface functions appropriate for the instrument.

Table 8-2 Interface functions

Control character	Interface function
SH1	Handshake source function (source handshake), full capability
AH1	Handshake sink function (acceptor handshake), full capability
L4	Listener function, full capability, deaddressed by MTA.
T6	Talker function, full capability, ability to respond to serial poll, deaddressed by MLA
SR1	Service request function (Service Request), full capability
PP1	Parallel poll function, full capability
RL1	Remote/Local switch over function, full capability
DC1	Reset function (Device Clear), full capability
DT1	Trigger function (Device Trigger), full capability
C0	No controller function

IEC Bus Messages

The messages transferred via the data lines of the IEC bus can be divided into two groups:

- **interface messages** and
- **instrument messages.**

Interface Messages

Interface messages are transferred on the data lines of the IEC Bus when the "ATN" control line is active (LOW). They are used for communication between controller and instruments and can only be sent by the controller which currently has control of the IEC Bus.

Universal Commands

The universal commands are encoded 10 - 1F hex. They affect all instruments connected to the bus without addressing.

Table 8-3 Universal Commands

Command	QuickBASIC command	Effect on the instrument
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument settings.
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default setting.
LLO (Local Lockout)	IBCMD (controller%, CHR$(17))	The LOC/IEC ADDR key is disabled.
SPE (Serial Poll Enable)	IBCMD (controller%, CHR$(24))	Ready for serial poll.
SPD (Serial Poll Disable)	IBCMD (controller%, CHR$(25))	End of serial poll.
PPU (Parallel Poll Unconfigure)	IBCMD (controller%, CHR$(21))	End of the parallel-poll state.

Addressed Commands

The addressed commands are encoded 00 - 0F hex. They are only effective for instruments addressed as listeners.

Table 8-4 Addressed Commands

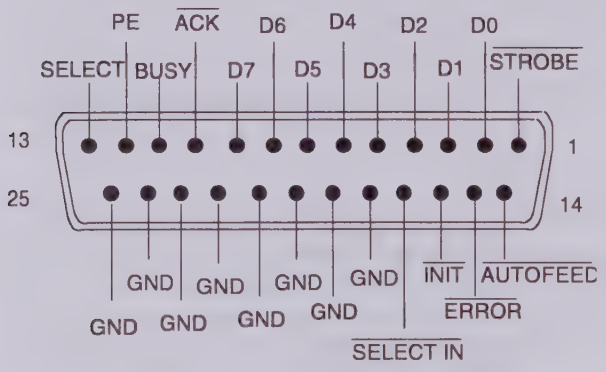
Command	QuickBASIC command	Effect on the instrument
SDC (Selected Device Clear)	IBCLR (device%)	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GTL (Go to Local)	IBLOC (device%)	Transition to the "Local" state (manual control).
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configure instrument for parallel poll. Additionally, the QuickBASIC command executes PPE/PPD.

Instrument Messages

Instrument messages are transferred on the data lines of the IEC bus when the "ATN" control line is not active. ASCII code is used.
Structure and syntax of the instrument messages are described in Chapter 5. The commands are listed and explained in detail in Chapter 6.

Printer Interface (LPT)

The 25-pin LPT connector on the rear panel of the Fig. 8-4 is provided for the connection of a printer. The LPT interface is compatible with the CENTRONICS printer interface.



Pin	Signal	Input (I) Output (O)	Description
1	STROBE	O	Pulse for transmitting a data byte, min. 1µs pulse width (active LOW)
2	D0	O	Data Line 0
3	D1	O	Data Line 1
4	D2	O	Data Line 2
5	D3	O	Data Line 3
6	D4	O	Data Line 4
7	D5	O	Data Line 5
8	D6	O	Data Line 6
9	D7	O	Data Line 7
10	ACK	I	Indicates that the printer is ready to receive the next byte. (active LOW)
11	BUSY	I	Signal is active when the printer cannot accept data. (active HIGH)
12	PE	I	Signal is active when the paper tray is empty. (active HIGH)
13	SELECT	I	Signal is active when the printer is selected. (active HIGH)
14	AUTOFEED	O	When signal is active, the printer automatically performs a linefeed after each line. (active LOW)
15	ERROR	I	This signal is high when the printer has no paper, is not selected or has an error status. (active LOW)
16	INIT	O	Initialize the printer. (active LOW)
17	SELECT IN	O	If signal is active, the codes DC1/DC3 are ignored by the printer. (active LOW).
18 - 25	GND		Ground connection.

Fig. 8-4 Pin assignments for the LPT connector.

RS-232-C Interface (COM)

The standard FSP is equipped with a serial interfaces (RS-232-C; COM connector at the rear of the instrument). The interface can be set up and activated manually in the *SETUP-GENERAL SETUP* menu in the *COM PORT*table (Selection *OWNER = INSTRUMENT*).

Interface Characteristics

Serial data transmission in asynchronous mode
Bi-directional data transfer via two separate lines
Transmission rate selectable from 110 to 19200 baud
Logic '0' signal from+3 V to +15 V
Logic '1' signal from -15 V to -3 V
An external instrument (controller) can be connected.

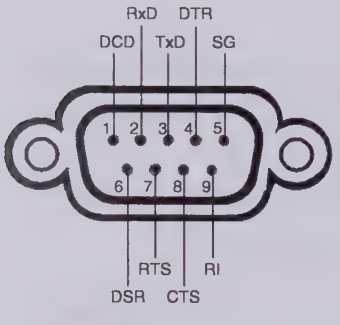


Fig. 8-5 Pin assignment of the RS-232-C interface

Signal Lines

DCD (Data Carrier Detect),
Not used in FSP.
Input; active LOW.
Using this signal, the local terminal recognizes that the modem of the remote station receives valid signals with sufficient level. DCD is used to disable the receiver in the local terminal and prevent reading of false data if the modem cannot interpret the signals of the remote station.

RxD (Receive Data)
Input, LOW = logic '1', HIGH = logic '0'.
Data line, local terminal receives data from remote station.

TxD (Transmit Data)
Output, LOW = logic '1', HIGH = logic '0'.
Data line, local terminal transmits data to remote station.

DTR (Data Terminal Ready),
Output, active LOW,
Indicates that the local terminal is ready to receive data.

GND
Interface ground, connected to instrument ground

DSR (Data Set Ready),
Input, active LOW,
Indicates that the remote station is ready to receive data.

RTS (Request To Send),
Output, active LOW.
Indicates that the local terminal wants to transmit data.

CTS (Clear To Send),
Input, active LOW.
Used to tell the local terminal that the remote station is ready to receive data.

RI (Ring Indicator),
Not used in FSP.
Input, active LOW.
Used by a modem to indicate that a remote station wants to establish a connection.

Transmission Parameters

To ensure error-free data transmission, the parameters of the instrument and the controller must have the same settings. The parameters are defined in the *SETUP-GENERAL SETUP* menu.

Transmission rate (baud rate) — the following transmission rates can be set in the analyzer: 110, 300, 600, 1200, 2400, 4800, 9600, 19200.

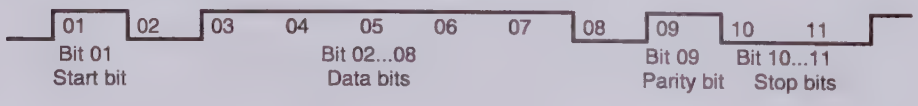
Data bits — Data transmission is in 7- or 8-bit ASCII code. The first bit transmitted is the LSB (least significant bit).

Start bit — Each data byte starts with a start bit. The falling edge of the start bit indicates the beginning of the data byte.

Parity bit — In order to detect errors, a parity bit may be transmitted. No parity, even parity or odd parity may be selected. In addition, the parity bit can be set to logic '0' or to logic '1'.

Stop bits — The transmission of a data byte is terminated by 1, 1,5 or 2 stop bits.

Example:
Transmission of character 'A' (41 hex) in 7-bit ASCII code, with even parity and 2 stop bits:



Control Characters

For interface control, several strings are defined and control characters are reserved which are based upon IEC Bus control.

Table 8-5 Control strings or control characters of the RS-232 interface

Control string or character	Function
'@REM'	Switch over to remote
'@LOC'	Switch over to local
'@SRQ'	Service Request SRQ (SRQ is sent by the instrument)
'@GET'	Group Execute Trigger (GET)
'@DCL'	Reset instrument (Device Clear DCL)
<Ctrl Q> 11 Hex	Enables character output / XON
<Ctrl S> 13 Hex	Inhibits character output / XOFF
0D Hex, 0A Hex	Terminator <CR>, <LF>

Handshake

Software handshake

In the software handshake mode of operation, the data transfer is controlled using the two control characters XON / XOFF.

The instrument uses the control character XON to indicate that it is ready to receive data. If the receive buffer is full, it sends the XOFF character via the interface to the controller. The controller then interrupts the data output until it receives another XON from the instrument. The controller indicates to the instrument that it is ready to receive data in the same way.

Cable required for software handshake

The connection of the instrument with a controller for software handshake is made by crossing the data lines. The following wiring diagram applies to a controller with a 9-pin or 25-pin configuration.

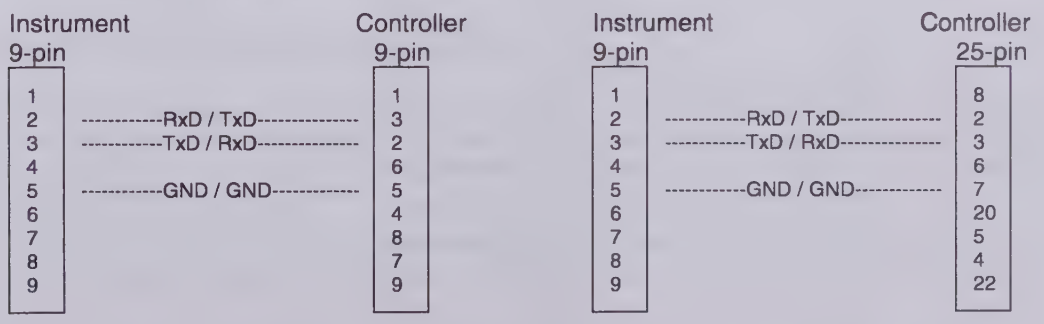


Fig. 8-1 Wiring of the data lines for software handshake

Hardware handshake

For hardware handshake, the instrument indicates that it is ready to receive data via the lines DTR and RTS. A logic '0' on both lines means 'ready' and a logic '1' means 'not ready'. The RTS line is always active (logic '0') as long as the serial interface is switched on. The DTR line thus controls the readiness of the instrument to receive data.

The readiness of the remote station to receive data is reported to the instrument via the CTS and DSR line. A logic '0' on both lines activates the data output and a logic '1' on both lines stops the data output of the instrument. The data output takes place via the TxD line.

Cable for hardware handshake

The connection of the instrument to a controller is made with a so-called zero modem cable. Here, the data, control and acknowledge lines must be crossed. The following wiring diagram applies to a controller with a 9-pin or 25-pin configuration.

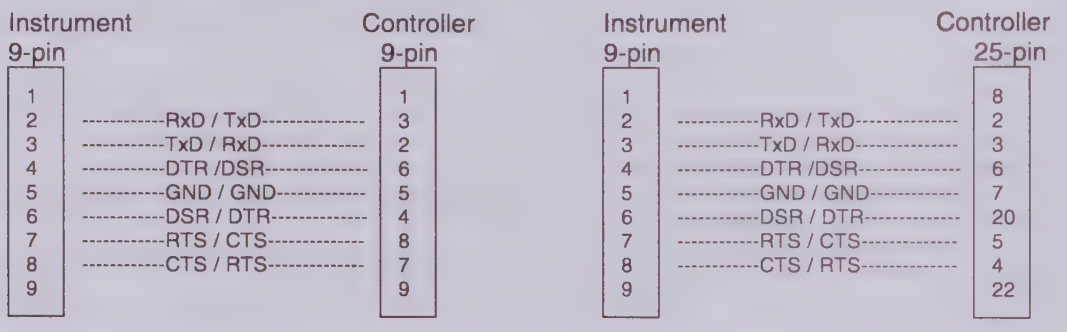
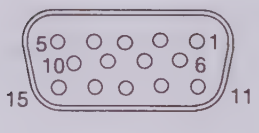


Fig. 8-2 Wiring of the data, control and acknowledge lines for hardware handshake

Monitor Connector (MONITOR)



Pin	Signal
1	R
2	G
3	B
4	(NC)
5	GND
6	GND
7	GND
8	GND
9	GND
10	GND
11	(NC)
12	(NC)
13	HSYNC
14	VSYNC
15	(NC)

Fig. 8-6 Pin assignments of the MONITOR connector.

Noise Source Control (NOISE SOURCE)

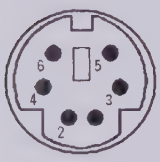
Using the NOISE SOURCE connector, an external noise source can be switched on/off, in order, e.g., to measure the noise figure of Units Under Test (UUTs). Usual noise sources require a +28 V signal to be turned on. At 0 V, they are turned off. These supply voltages are delivered by the connector. Maximum current is 100 mA.

External Trigger Input (EXT TRIG/GATE)

The EXT TRIG/GATE connector is used for controlling the measurement via an external signal. The trigger voltages are TTL level (Low < 0.7 V, High > 1.4 V), typ. input impedance is 10 kOhm

Mouse Connector (MOUSE)

A PS/2 connector is provided at the rear panel to connect a PS/2 mouse:



Pin	Signal
1	MOUSEDATA
2	KEYBOARDDATA
3	MOUSEGND
4	MOUSEVD5
5	MOUSECLK
6	KEYBOARDCLK

Fig 8-7 Pin assignments for the MOUSE connector.

Reference Output/Input (REF IN and REF OUT)

For operation with an external reference, the internal reference oscillator is then synchronized to the 10-MHz reference applied to the connector. The necessary level is > 0 dBm.

The internal 10 MHz reference signal is also available at the REF OUT connector and thus provides the capability of, e.g., synchronization of external instruments to the FSP. The output level is 0 dBm.

Switchover between internal and external reference is possible in the *SETUP* menu.

IF Output 20.4 MHz (20.4 MHz OUT)

The 2o,4 MHz IF signal of the FSP is available at the 20.4 MHz OUT BNC connector. The bandwidth corresponds to the selected bandwidth for a resolution bandwidth between 100 kHz and 10 MHz. For a resolution bandwidth below 100 kHz, the bandwidth of the output is 2.6 times the resolution bandwidth with a minimum of 2.6 kHz.

The signal level at the IF output is 0 dBm for resolution bandwidth ≥ 100 kHz, and –10 dBm for resolution bandwidth < 100 kHz (mixer level ≥ 60 dBm) .

Contents - Chapter 9 "Error Messages"

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Device-Specific Messages 9.8

9 Error Messages

Error messages are entered in the error/event queue of the status reporting system in the remote control mode and can be queried with the command SYSTem:ERRor?. The answer format of FSP to the command is as follows:

<error code>, "<error text with queue query>;
<remote control command concerned>"

The indication of the remote control command with prefixed semicolon is optional.

Example:

The command "TEST:COMMAND" generates the following answer to the query SYSTem:ERRor? :

-113,"Undefined header;TEST:COMMAND"

The subsequent list contains the description of error texts displayed on the instrument.

Distinction is made between error messages defined by SCPI, which are marked by negative error codes, and the device-specific error messages for which positive error codes are used.

The right-hand column in the following tables contains the error text in bold which is entered in the error/event queue and can be read out by means of query SYSTem:ERRor?. A short explanation of the error cause is given below. The left-hand column contains the associated error code.

SCPI-Specific Error Messages

No Error

Error code	**Error text in the case of queue poll** Error explanation
0	**No error** This message is output if the error queue does not contain any entries.

Command Error - Faulty command; sets bit 5 in the ESR register.

Error code	**Error text in the case of queue poll** Error explanation
-100	**Command Error** The command is faulty or invalid.
-101	**Invalid Character** The command contains an invalid sign. Example: A header contains an ampersand, "**SENSe&**".
-102	**Syntax error** The command is invalid. Example: The command contains block data the instrument does not accept.
-103	**Invalid separator** The command contains an impermissible sign instead of a separator. Example: A semicolon is missing after the command.
-104	**Data type error** The command contains an invalid value indication. Example: ON is indicated instead of a numeric value for frequency setting.
-105	**GET not allowed** A Group Execute Trigger (GET) is within a command line.
-108	**Parameter not allowed** The command contains too many parameters. Example: Command **SENSe:FREQuency:CENTer** permits only one frequency indication.

Continuation: Command Error

Error code	Error text in the case of queue poll Error explanation
-109	**Missing parameter** The command contains too few parameters. Example: The command **SENSe:FREQuency:CENTer** requires a frequency indication.
-110	**Command header error** The header of the command is faulty.
-111	**Header separator error** The header contains an impermissible separator. Example: the header is not followed by a "White Space", "***ESE255**"
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is not defined for the instrument. Example: ***XYZ** is undefined for every instrument.
-114	**Header suffix out of range** The header contains an impermissible numeric suffix. Example: **SENSe3** does not exist in the instrument.
-120	**Numeric data error** The command contains a faulty numeric parameter.
-121	**Invalid character in number** A number contains an invalid character. Example: An "A" in a decimal number or a "9" in an octal number.
-123	**Exponent too large** The absolute value of the exponent is greater than 32000.
-124	**Too many digits** The number includes too many digits.
-128	**Numeric data not allowed** The command includes a number which is not allowed at this position. Example: The command **INPut:COUPling** requires indication of a text parameter.
-130	**Suffix error** The command contains a faulty suffix.
-131	**Invalid suffix** The suffix is invalid for this instrument. Example: nHz is not defined.
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix is not allowed for this command or at this position of the command. Example: The command ***RCL** does not permit a suffix to be indicated.
-140	**Character data error** The command contains a faulty text parameter
-141	**Invalid character data** The text parameter either contains an invalid character or it is invalid for this command. Example: Write error with parameter indication;**INPut:COUPling XC.**

Continuation: Command Error

Error code	**Error text in the case of queue poll** Error explanation
-144	**Character data too long** The text parameter contains more than 12 characters.
-148	**Character data not allowed** The text parameter is not allowed for this command or at this position of the command. Example: The command `*RCL` requires a number to be indicated.
-150	**String data error** The command contains a faulty string.
-151	**Invalid string data** The command contains a faulty string. Example: An END message has been received prior to the terminating apostrophe.
-158	**String data not allowed** The command contains a valid string at a position which is not allowed. Example: A text parameter is set in quotation marks, `INPut:COUPling "DC"`
-160	**Block data error** The command contains faulty block data.
-161	**Invalid block data** The command contains faulty block data. Example: An END message was received prior to reception of the expected number of data.
-168	**Block data not allowed** The command contains valid block data at an impermissible position. Example: The command `*RCL` requires a number to be indicated.
-170	**Expression error** The command contains an invalid mathematical expression.
-171	**Invalid expression** The command contains an invalid mathematical expression. Example: The expression contains mismatching parentheses.
-178	**Expression data not allowed** The command contains a mathematical expression at an impermissible position.

Execution Error - Error on execution of a command; sets bit 4 in the ESR register

Error code	**Error text in the case of queue poll** Error explanation
-200	**Execution error** Error on execution of the command.
-201	**Invalid while in local** The command is not executable while the device is in local due to a hard local control. Example: The device receives a command which would change the rotary knob state, but the device is in local so the command can not be executed.
-202	**Settings lost due to rtl** A setting associated with hard local control was lost when the device changed to LOCS from REMS or to LWLS from RWLS.
-210	**Trigger error** Error on triggering the device.
-211	**Trigger ignored** The trigger (GET, *TRG or trigger signal) was ignored because of device timing considerations. Example: The device was not ready to respond.
-212	**Arm ignored** An arming signal was ignored by the device.
-213	**Init ignored** Measurement initialisation was ignored as another measurement was already in progress.
-214	**Trigger deadlock** The trigger source for the initiation of measurement is set to GET and subsequent measurement is received. The measurement cannot be started until a GET is received, but the GET would cause an interrupted-error)
-215	**Arm deadlock** The trigger source for the initiation of measurement is set to GET and subsequent measurement is received. The measurement cannot be started until a GET is received, but the GET would cause an interrupted-error.
-220	**Parameter error** The command contains a faulty or invalid parameter.
-221	**Settings conflict** There is a conflict between setting of parameter value and instrument state.
-222	**Data out of range** The parameter value lies out of the permissible range of the instrument.
-223	**Too much data** The command contains too many data. Example: The instrument does not have sufficient storage space.
-224	**Illegal parameter value** The parameter value is invalid. Example: The text parameter is invalid , **`TRIGger:SWEep:SOURce TASTe`**

Continuation: Execution Error

Error code	**Error text in the case of queue poll** Error explanation
-230	**Data corrupt or stale** The data are incomplete or invalid. Example: The instrument has aborted a measurement.
-231	**Data questionable** The measurement accuracy is suspect.
-240	**Hardware error** The command cannot be executed due to problems with the instrument hardware.
-241	**Hardware missing** Hardware is missing. Example: An option is not fitted.
-250	**Mass storage error** A mass storage error occured.
-251	**Missing mass storage** The mass storage is missing. Example: An option is not installed.
-252	**Missing media** The media is missing. Example: There is no floppy in the floppy disk drive.
-253	**Corrupt media** The media is corrupt. Example: The floppy is bad or has the wrong format.
-254	**Media full** The media is full. Example: There is no room on the floppy.
-255	**Directory full** The media directory is full.
-256	**File name not found** The file name cannot be found on the media.
-257	**File name error** The file name is wrong. Example: An attempt is made to copy to a duplicate file name.
-258	**Media protected** The media is protected. Example: The write-protect tab on the floppy is present.
-260	**Expression error** The expression contains an error.

Device Specific Error; sets bit 3 in the ESR register

Error code	Error test in the case of queue poll Error explanation
-300	**Device-specific error** FSP-specific error not defined in greater detail.
-310	**System error** This error message suggests an error within the instrument. Please inform the R&S Service.
-313	**Calibration memory lost** Loss of the non-volatile data stored using the *CAL? command. This error occurs when the correction data recording has failed.
-330	**Self-test failed** The selftest could not be executed.
-350	**Queue overflow** This error code is entered in the queue instead of the actual error code if the queue is full. It indicates that an error has occurred but not been accepted. The queue can accept 5 entries.

Query Error - Error in data request; sets bit 2 in the ESR register

Error code	Error text in the case of queue poll Error explanation
-400	**Query error** General error occurring when data are requested by a query.
-410	**Query INTERRUPTED** The query has been interrupted. Example: After a query, the instrument receives new data before the response has been sent completely.
-420	**Query UNTERMINATED** The query is incomplete. Example: The instrument is addressed as a talker and receives incomplete data.
-430	**Query DEADLOCKED** The query cannot be processed. Example: The input and output buffers are full, the instrument cannot continue operation.
-440	**Query UNTERMINATED after indefinite response** A query is in the same command line after a query which requests an indefinite response.

Device-Specific Messages

Error code	**Error text in the case of queue poll** Error explanation
1036	**MS: The correction table based amplifier gain exceeds the amplifier range for CALAMP1 and CALAMP2 on IF board** This message is output when the setting range of the calibration amplifier is not sufficient for the required correction. The error occurs only with modules which are not correcty adjusted or defective.
1052	**Frontend LO is Unlocked** This message is output when the phase regulation of the local oscillator fails in the RF frontend.
1060	**Trigger-Block Gate Delay Error- gate length < Gate Delay** This message is output when the gate signal length is not sufficient for the pull-in delay with a predefined gate delay.
1064	**Tracking LO is Unlocked** This message is output when the phase regulation of the local oscillator fails on the tracking generator module.

Error code	**Error text in the case of queue poll** Error explanation
2022	**OPTIONS.INI invalid** This message is output when an error has been recognized in the file OPTIONS.INI which contains the clearing codes for retrofitable firmware applications. If this file is not correctly recognized, all firmware applications are blocked for this instrument.
2028	**Hardcopy not possible during measurement sequence** This message is output when a printout is started during scan sequences that cannot be interrupted. Such sequences are for example: • Recording the system error correction data (calibration) • Instrument selftest In such cases a synchronization to the end of the scan sequence should be performed prior to starting the printout.
2033	**Printer Not Available** This message is output when the selected printer is not included in the list of available output devices. A possible cause is that the required printer driver is missing or incorrectly installed.
2034	**CPU Temperature is too high** This message is output when the temperature of the processor exceeds 70 °C.

10 Index

Note: *All softkeys are listed alphabetically under keyword "Softkey" with their names. The page numbers 4.xxx refer to the detailed description of the softkeys in chapter 4. Generally, the number of the page in chapter 6 containing the equivalent remote control command is given in addition.*
A list of softkeys and equivalent remote control commands or command sequences is given in chapter 6, section "Table of Softkeys with IEC/IEEE-Bus Command Assignment".
Chapter 6 also contains an alphabetical list of all remote control commands.

*

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Zero span ... 4.12
Zoom ... 4.55
amplitude ... 4.35
x-AXIS (gate signal) ... 4.30

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